POWER

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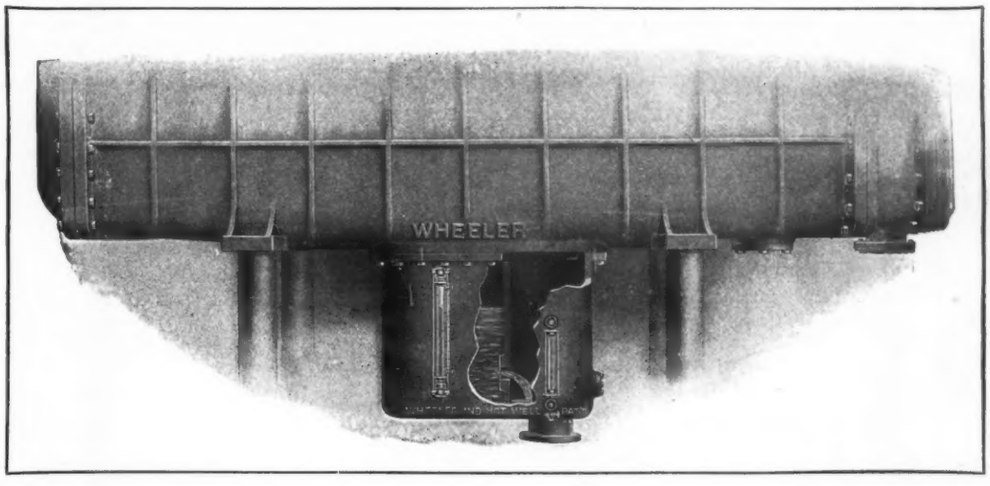
THE WHEELER INDICATING HOT WELL



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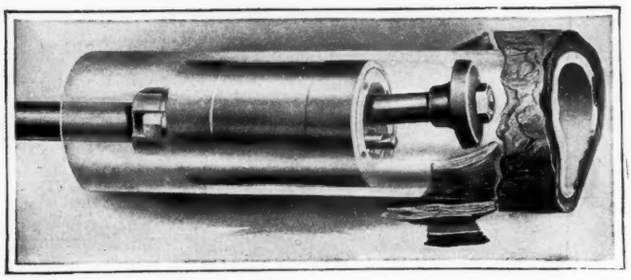

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The Dean is too well known to need defense, but there are those who might mistake our indifference to competitors' claims for inability to answer them.

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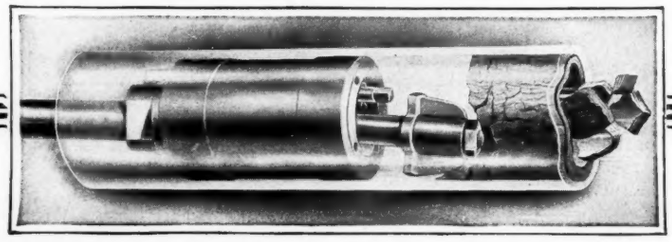

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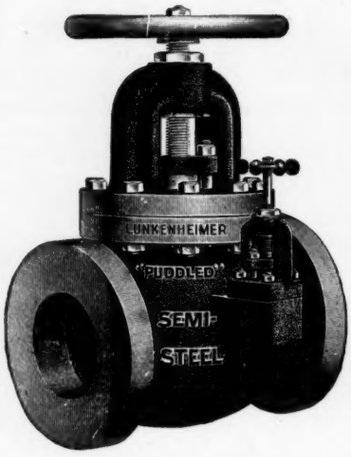

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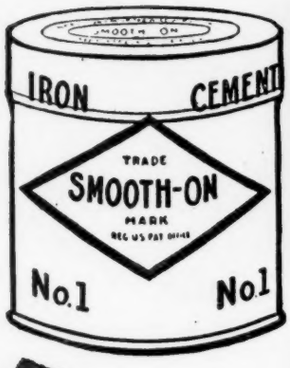

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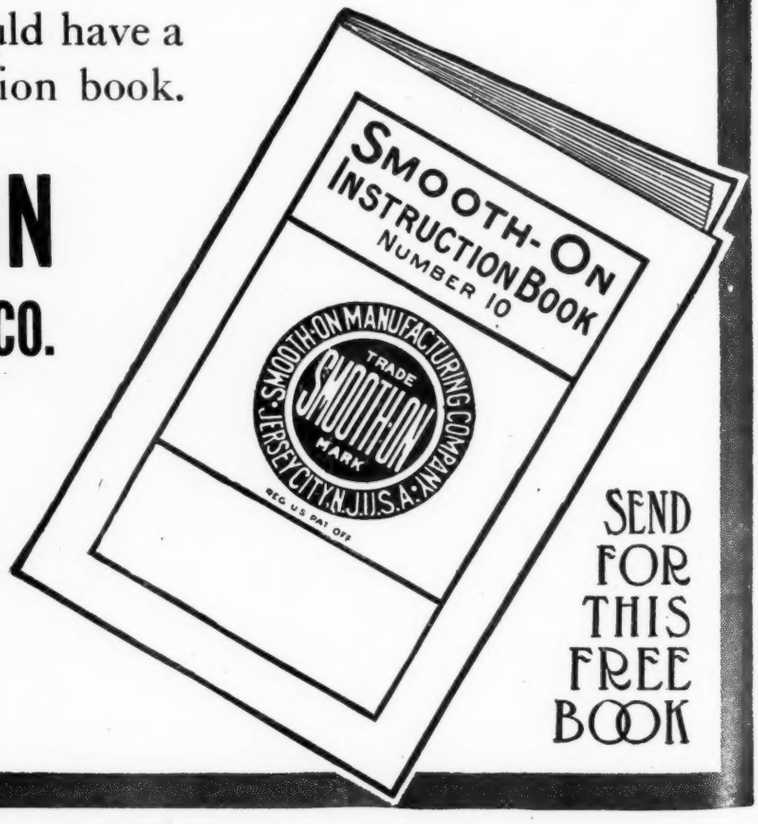

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POWER

Vol. 35 NEW YORK, APRIL 23, 1912 No. 17

If You Have a "Kick" Coming, Let Us Have It!

THE publisher of, let us call it, the *Excelsior Banner* every so often would enter the paper's editorial rooms and demand:

"What's wrong with the *Banner?* Had nothing but pats on the back for the past two weeks. I want kicks! Then I know the paper's making a noise, and the readers are interested."

That's us!

We like the "pats," but we want every one of our thirty thousand readers to know that the swift kick planted on that portion of our anatomy which old Mother Nature has wisely cushioned to sustain the shock of a kick, wakes us up and keeps us moving in the forward and upward direction.

We want to know just what you think of the paper; what you like about it; what you dislike; how you think it can be improved.

1. **What article most interests you in this issue?**
2. **Which is most helpful to you in power-plant operation?**
3. **What change would you suggest to make POWER a better paper?**
4. **Have you ever written anything for the paper? If not, why?**
5. **Do you think the articles should be wholly confined to conditions of operating practice?**
6. **Do you want more reminiscences, humor, anecdotes?**
7. **Have you availed yourself of the Inquiries of General Interest page? Do you know it is your privilege to ask questions and to get the right answers?**
8. **What profit have you derived from the "discussions" pages?**
9. **Has POWER said too little or too much on any one subject?**
10. **If you are keeping a card index, does the Outline of Topics page answer your requirements?**
11. **Do you know that we pay for news, facts, ideas?**
12. **POWER has got many positions for operating engineers. Is your name on our list?**
13. **What else can you suggest that we have omitted to mention?**

We want you to consider POWER *your* paper as well as ours.

In the issue of March 12 we asked you to collaborate with us in gathering news of boiler explosions, flywheel accidents, new power-plant installations, etc., and the prompt response that was made to our appeal strongly inclines us to the belief that as many readers, and even more, will again respond to the inquiries "paneled" in the center of this page.

Give us your frank and honest criticism. Write us a letter telling us just what you think. What you write will be for our instruction, not for publication.

We want to make POWER an even better paper than it now is and, may be, *your* "kick" will do it. This is an open game, so chalk your cue and name your shot. Now kick, and kick hard!

Large Swedish Hydro-Electric Plant

By J. B. Van Brussel

A 100,000-hp. plant employing horizontal turbines running under a head of 100 ft. The plant was built by the Swedish Government at the unusually low figure of $31 per horsepower capacity.

The Swedish government is erecting at Trollhättan a hydro-electric plant which when completed will have a maximum capacity of 100,000 hp., half of this being already installed.

The plant is located on the eastern bank of the Göta River, a stream connecting Lake Vänern, the largest lake in Sweden, with the sea. This lake covers an area of 2180 square miles and the difference between its level and that of the sea is 144 ft., of which 108 ft. is at the Trollhättan Falls. The present flow under low-water conditions is 11,520 cu.ft. per second and at high water 32,400 cu.ft.; the plant is designed to utilize 9000 cu.ft. per second.

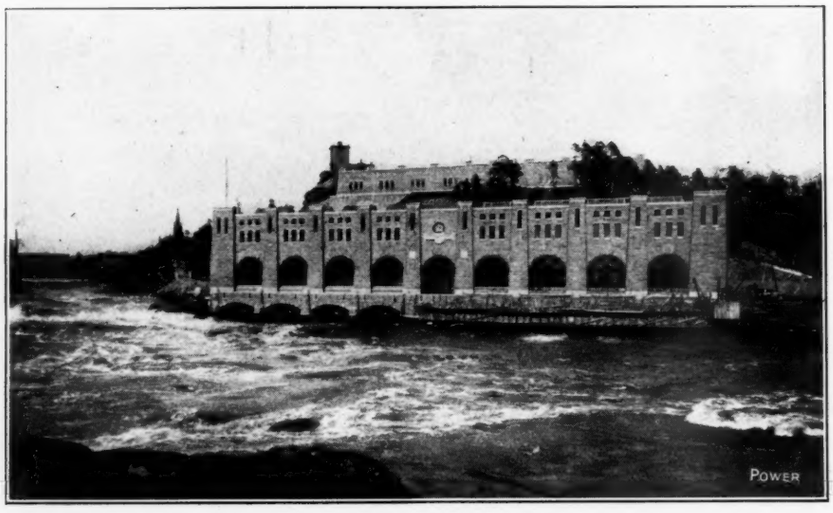


FIG. 1. TURBINE HOUSE

The regulating dam across the river is constructed with four openings, separated by granite piers. The two central openings each have a free width of 65½ ft., and are closed by means of bear-trap or roller-dams. The westerly opening is 64 ft. 8 in. wide and is closed by means of five sluice gates. The eastern outlet is 11 ft. 2 in. wide and is fitted with a similar gate. The outlets can be closed for repairs by means of steel needles resting partly against the bridgeway on the pillar, and partly against the sill. This type of construction was chosen on account of the quantities of ice which are carried down the river during the winter. When there is plenty of water, the ice makes its escape through the fully opened central outlets, and with lower water levels it is led away under the partly raised rollers or through the sluice gates.

The intake to the power station is 394 ft. above the dam, and consists of six openings 39 ft. 6 in. broad, separated by brick piers and provided with gates. Under ordinary conditions the speed of the water at the inlet is about 3 ft. 3 in. per second.

The length of the intake canal is 1418 yd., and in the sides of the distribution basin are wooden outlets, to provide for the water flowing through the canal, and thus to prevent flooding the power house in case the majority of the turbine regulators should be simultaneously closed. The water is led in tunnels from these outlets into the river.

There will be eight main turbine units having a maximum capacity of 12,500 hp. and three exciter units. The turbines are of the twin, horizontal Francis type direct-connected to the generators and operate under a head of 100 ft. at a speed of 187.5 r.p.m. The curves, Fig. 9, show the efficiency of one of these turbines as developed on a test.

The smallest interior diameter of the turbine casing is 16½ ft., and the largest diameter is 18 ft. Most parts, especially those exposed to the severest strains are of steel, and each turbine has been tested at a pressure corresponding to a head of 246 ft. of water. Each shaft is made in three parts, connected by couplings and is supported by bearings employing ring lubrication. Two of these bearings, for each machine, are placed against the turbine casing and are accessible for inspection by means of vertical pits. All the bearings are water-cooled and are fitted with thermometers.

In order to obtain a construction combining the greatest possible reliability in working with easy management and durability, all the parts belonging to the governing mechanism have been located outside the turbine-casing so that all the journals can be lubricated and inspected while the machines are in operation.

The construction of these turbines makes it possible to take out each guide-blade separately without causing any serious disturbance beyond the removal of the box belonging to the blade in question and the uncoupling of the small

FIG. 2. ENTRANCE TO INTAKE TUNNELS

chain between the crank and the regulator. The governor, which is driven by a belt from the turbine shaft, together with the pressure bell, is placed in a cast-iron casing, which also serves as an oil receptacle. The oil pump is also driven by a belt from the turbine axle.

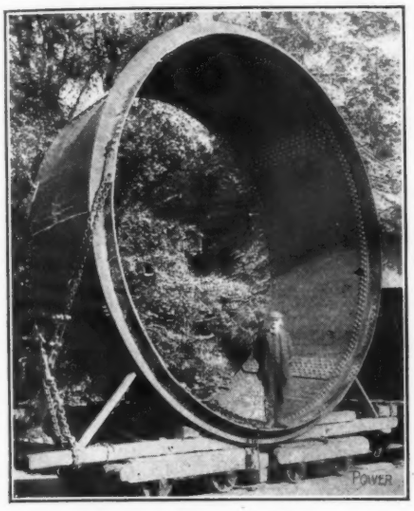


FIG. 3. SECTION OF SUCTION CASING

form. The weight of each of the large turbines complete is about 115 tons.

The generators produce three-phase 25-cycle currents at 10,000 volts. They are entirely encased and draw by suction the cold air through conduits which pass within the walls of the power station and underneath its floor. The air heated in the generators is also led away through conduits; in the winter, however, it is used for warming the station.

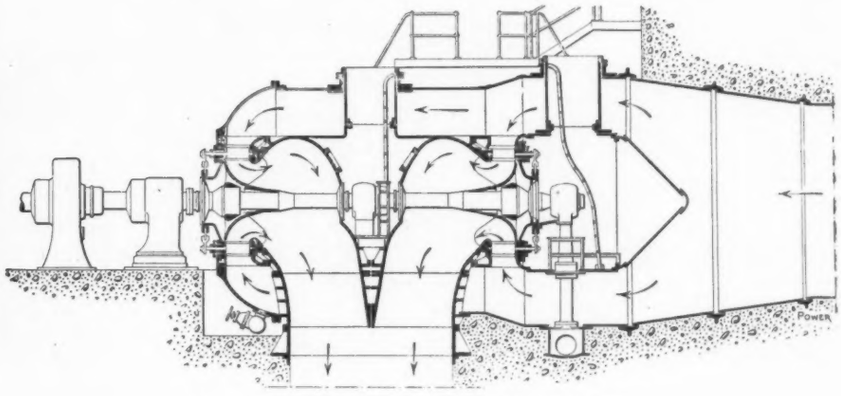


FIG. 4. SECTION THROUGH TURBINE CASING

For excitation, lighting purposes and power to the auxiliary machines, there is a direct-current installation at 220 volts. This consists of three 500-hp. turbines, each connected direct to a 350-kw. direct-current generator. Connected in parallel with these generators is a storage battery having a capacity of 4800 ampere-hours. The direct-current switchboard is placed on a balcony in the center of the turbine room.

The main switching equipment is located in a separate building about 650 ft. distant from the main station, the cables being led to it through an underground tunnel. In addition to containing the switching equipment this building also contains the transformers, three to each generator, which step up the

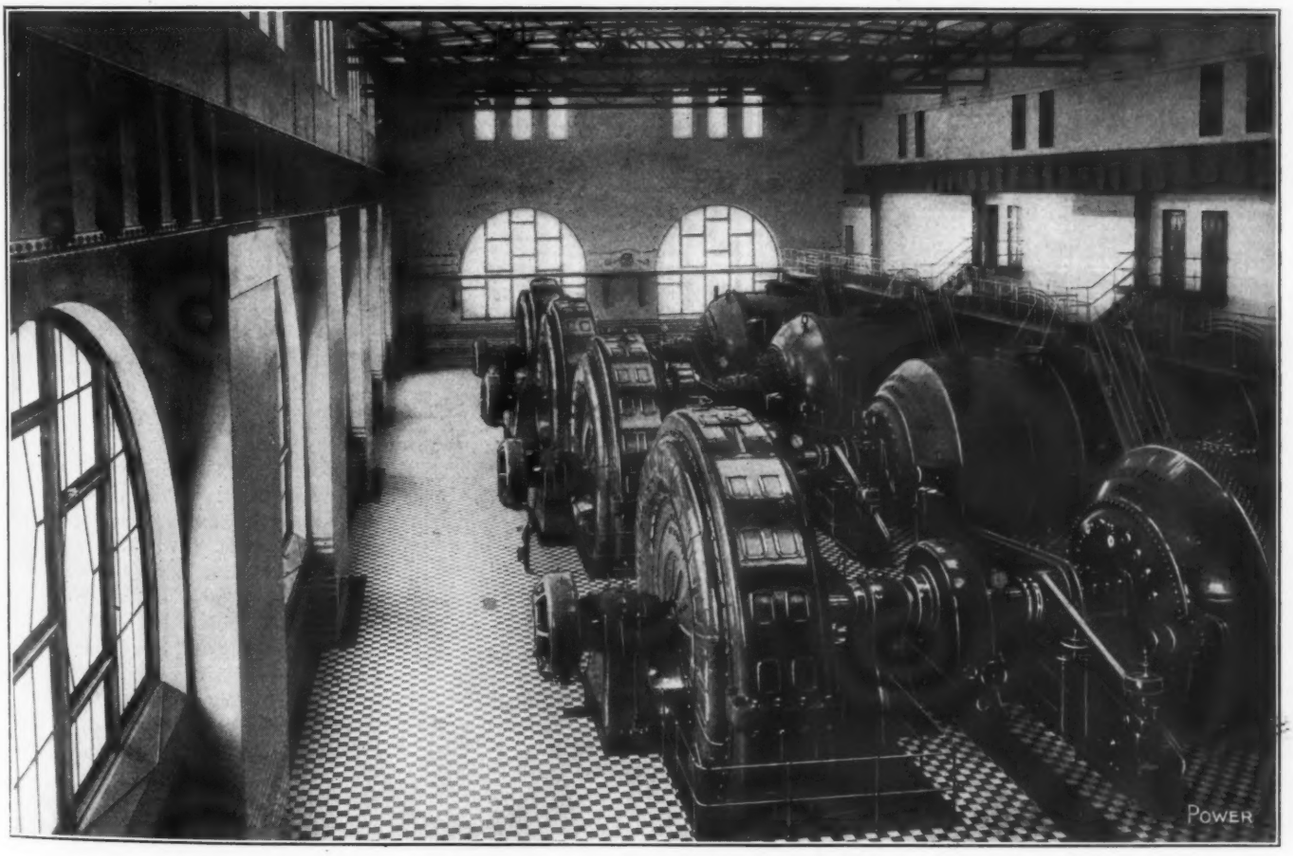


FIG. 5. SHOWING MAIN UNITS

The brake intended to bring the turbine to a standstill is hydraulic in principle, and is worked from the starting plat-

voltage from 10,000 to 50,000 volts. These are oil insulated and water cooled, arrangements being provided for draining off the oil in case of fire. In the center of this building is a room from which the station is controlled. On marble switchboards and desks are placed all the instruments necessary for ascertaining the load distribution of the alternating-current system, as well as all the requisite signal and warning appliances.

The energy is distributed partly at 10,000 volts and partly at 50,000 volts. The long-distance lines are laid out for either the total output of a generator or for half its output; in the latter case they are in pairs. This makes it possible for each generator, with or without transformation of the voltage, to supply energy for a fixed number of lines and to work independently of the other generators; in other words, the installation can be divided into several systems independent of each other.

The machines and the long-distance lines are protected against overload by means of automatic cutout switches. The extra-voltage protection for the long-distance lines consists of water jets for the dispersal of the static charge and of horn-gap lightning arresters with two horns in series with a resistance formed through running water as a rough protection. For smaller discharges horn-gap arresters with oil resistance are provided.

The 50,000-volt current is not supplied direct to the consumers, but is led to large substations belonging to the government. In these stations the energy is stepped down to a more convenient voltage, generally 10,000, and in isolated cases as low as 3000 or 6000 volts. The secondary stations are arranged on the same principle as the switch house.

The cost of the system was unusually low, involving a total expenditure of only $3,132,410, or about $31 per horsepower.

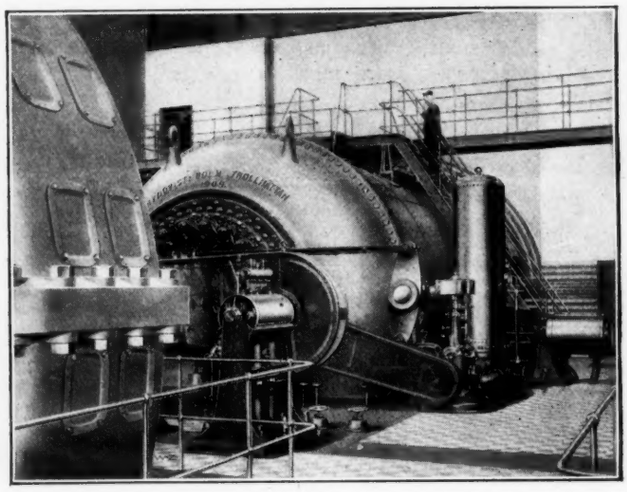


FIG. 6. ONE OF THE MAIN TURBINES SHOWING GOVERNOR

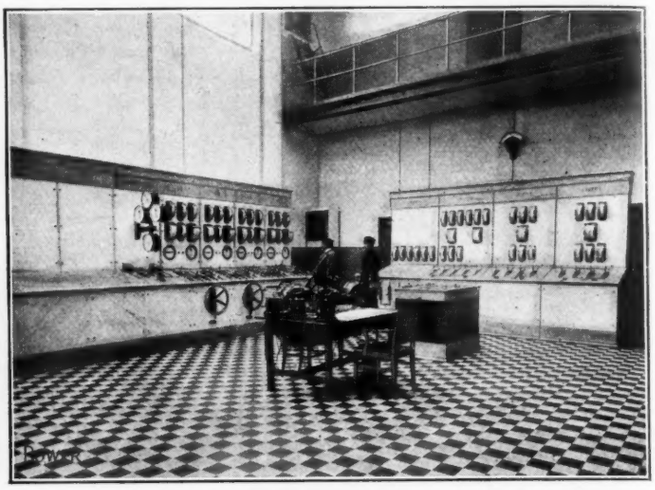


FIG. 7. SWITCHBOARD ROOM

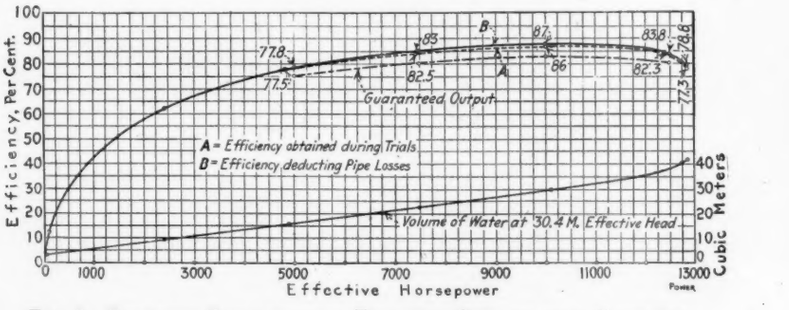


FIG. 9. SHOWING RESULTS OF A TEST ON ONE OF THE TURBINES

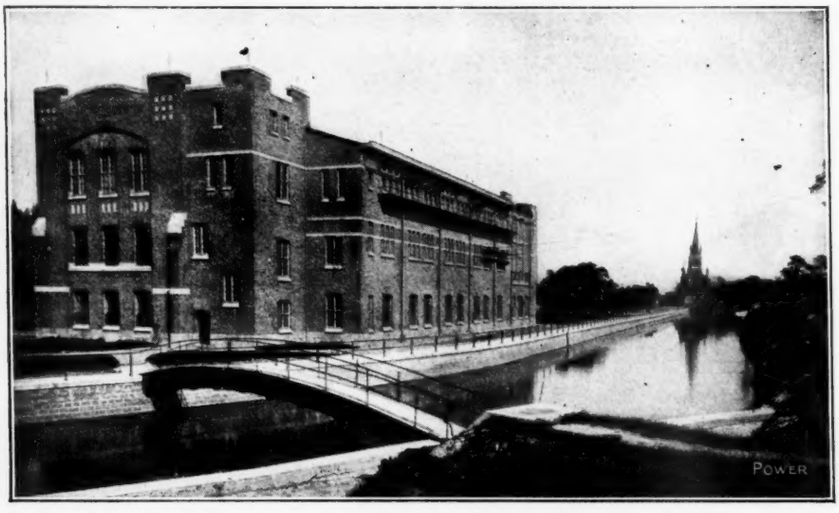


FIG. 8. SWITCH HOUSE AND CANAL

Study Questions

The answers to these questions will be given in the issue of Apr. 30.

1. What must be the diameter of a spherical cast-iron safety-valve weight to weigh 64 lb., the weight of the eye-piece being 3 lb.?
2. A noncondensing engine uses 28 lb. of steam per indicated horsepower per hour, the temperature of the feed water 204 deg. F. and the steam pressure 90 lb. gage. What would be the heat efficiency of the engine?
3. What makes a chimney draw?
4. What must be the diameter of the material of an open-link chain to safely carry 34,700 lb.?
5. If a governor ball weighing 12 lb. describes a path 2.5 ft. in diameter and travels at a rate of 282 ft. per minute, what will be the centrifugal force of the balls in pounds?

Notes on Exhaust Steam Accumulators

By Francis H. Davies

Descriptive of several exhaust-steam accumulators of English manufacture and their performance in connection with rolling-mill work.

The utilization of the energy contained in the exhaust steam of a reciprocating engine by means of a specially designed low-pressure turbine is not, as might be supposed, a new idea, the combination having formed the subject of a patent taken out some 70 years ago. It has remained, however, for the engineers of today to perfect the suggestion and to carry it into practice. The means taken to this end are of much interest, particularly where they relate to intermittently running engines such as those operating steam hammers, rolling mills, etc.

It is obvious that in ordinary practice the supply of exhaust steam from engines of this nature will vary considerably in quantity; furthermore, where it is desired to use the combined exhaust of several engines, each running more or less intermittently, the amount of steam available and the pressure fluctuations may vary over a still wider range.

System of Storage

This difficulty can only be met by a system of storage designed to absorb the surplus heat of the exhaust steam during periods of oversupply and to return it with a minimum loss when the supply falls below the demand of the turbine.

Several accumulators have been designed to produce this regenerative effect. One of the earliest is the scrap-metal accumulator which, although comparatively inefficient, is useful for small plants and still finds some employment. It consists of a cylindrical shell (generally an old boiler) the inside of which is packed with condemned rails stacked on top of one another parallel to the length of the shell. The exhaust steam enters at one end and leaves at the other, and the regenerative effect is produced by the condensed water lying in the interstices between the rails.

An important objection to this type of accumulator is the number and the consequent cost of the old rails required. For instance, a 24x6-foot shell will take 50 tons of rails, and for the output which such an accumulator is capable of handling, the space required is large. One of this size and type has been installed in connection with a 175-horsepower Rateau turbine, the load upon which is very erratic.

Rateau Accumulator

Professor Rateau has been extremely active in the development of the steam turbine, and among many other improvements for which he is responsible is the Rateau accumulator, which is illustrated diagrammatically in Fig. 1. The exhaust steam enters at the branch pipe, as shown, and from there passes to the oval tubes which are arranged in two or more pairs. These tubes are pierced on their adjacent sides about 12 inches below the water level with rows of small holes through which the steam flows to the water in the shell, rising and circulating in the direction indicated by the arrows. Above each pair of tubes there is a baffle plate, the function of which is to prevent priming, which would otherwise result from water being thrown up into the steam space by the bursting of steam bubbles on the surface. The level of the water in the shell is kept constant by a ball float valve controlling the intake on the right, and the blowoff valve on the top is set to relieve the accumulator, should the pressure rise materially above normal.

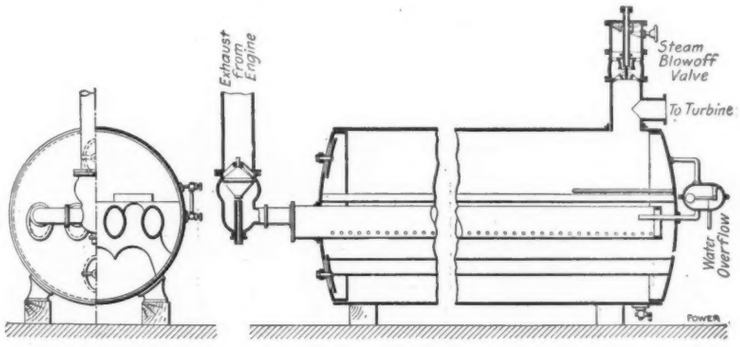


Fig. 1. Rateau Accumulator

Generally speaking, this type of accumulator in the size normally installed will regenerate a sufficient supply of steam for the turbine to permit the engine being stopped for about four minutes, but if the interval is longer than this it becomes necessary to admit live steam. This is done through the agency of a reducing valve which is set to admit live steam automatically to the shell at atmospheric pressure. The valve is controlled by the pressure in the accumulator, and by this means the installation is rendered free from all risk of stoppage through temporary failure of the exhaust-steam supply.

The diagrams shown in Fig. 2 are particularly interesting, contrasting as they do the effect produced with an empty receiver and one containing the necessary body of water. The test of which these diagrams are the result was made with a Rateau accumulator under the following conditions: The empty shell had a capacity of 7000 cubic feet, and into this was led the exhaust from a rolling-mill engine having two 40-inch cylinders and a 5-foot stroke. The turbine used 20,500 pounds of exhaust steam per hour at full load. In the case of the empty accumulator, which was then merely acting as a receiver, the pressure fluctuations were extreme, as shown in the upper diagram, and were such as to render steady running of the turbine impossible. On the other hand, with water standing at a depth of 11 inches above the holes in the oval pipes of the accumulator and at a temperature of 110 degrees Fahrenheit the pressure variation was greatly improved, showing in no case a fluctuation exceeding ¾ pound. It should also be noticed that, although the rolling-mill engine was stopped for 1¼ minutes after the second minute line of the chart, the drop in pressure was very gradual and negligible

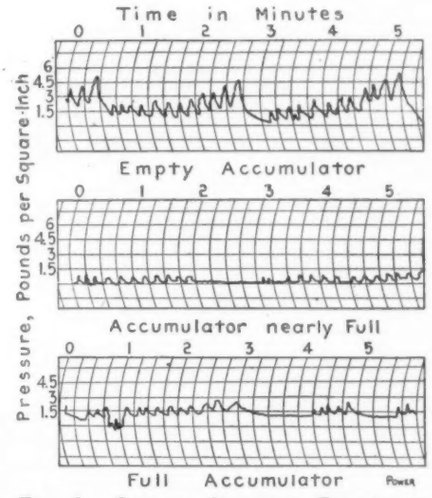


Fig. 2. Charts Showing Effect of Exhaust Steam Accumulator

in amount. The bottom chart was taken with a water level of 13 inches above the holes and at a temperature of 212 degrees Fahrenheit. It will be seen that the pressure is somewhat higher than before, the increased temperature of the water having slightly reduced the condensing effect on the exhaust steam.

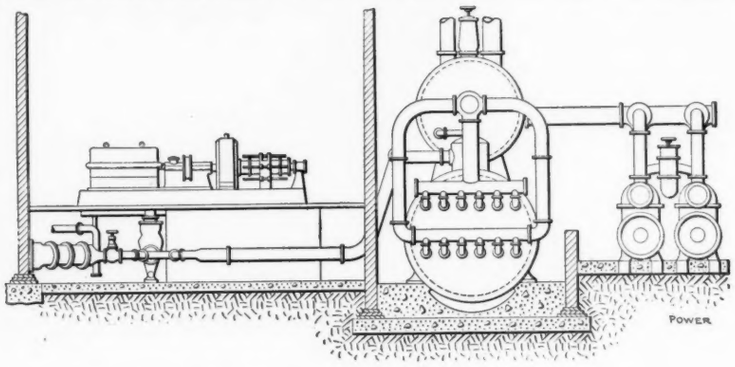


FIG. 3. LAYOUT OF EXHAUST STEAM TURBINE PLANT

LAYOUT OF EXHAUST-STEAM TURBINES

Fig. 3 shows the layout of an exhaust-steam turbine installation in a steel works, and gives a general idea of the usual arrangement. In this plant the engines which deliver about 41,000 pounds of steam per hour after deducting pipe condensation, etc., exhaust into the accumulator, and are made up of the following units: one two cylinder cogging engine having 40-inch cylinders and a 5-foot stroke; one finishing engine, with a 42-inch cylinder and a 5-foot stroke; two small mill engines and one 10-ton and one 4-ton steam hammer. The Rateau accumulator is shown surmounted by a shell receiver, the object of which is to reduce the shock of the incoming exhaust steam. The extra inlets on the top of the receiver are for connection to the rolling-mill engines. Leaving the accumulator, the steam passes through a large main to the turbines, which are each of 450 kilowatts capacity, and these in their turn exhaust to a barometric jet condenser, not shown in the sketch. At the far end of the turbines a high-pressure steam main is brought into the engine room, and this supplies low-pressure live steam to the turbines through a reducing valve at such times as the main engines are shut down for roll-changing, etc.

The accumulator is designed to deal with engine stoppages of 45 seconds when both turbines are working at full load, and it is interesting to note that after the main engines are shut off, one turbine has run on the steam delivered from the accumulator alone for six minutes at a load of 390 kilowatts, which dropped to 125 kilowatts at the end of nine minutes.

Another type of regenerative heat accumulator, manufactured by the Cruse Controllable Superheater Company, is illustrated in Fig. 4. The underlying principle is that the water, instead of lying in a mass, should be broken up into a fine shower in order to secure intimate contact with the exhaust steam and to keep the size of the accumulator down to a minimum. The exhaust steam enters at the bottom of the vessel *A* and emerges at the top on its way to the turbine. In its passage through the vessel it is met by the falling shower of water, the action of which alternates between heat absorption during periods of exhaust-steam supply and heat emission when the steam is cut off.

The heat-storage vessel *B* is originally filled with water from the main by the circulating pump, which then forces it round in a circuit through the two vessels. In its passage upward the exhaust steam passes through holes in the trays which are saw-edged, and at the top, in the condensing chamber, flows through the perforated baffle plates, the duty of which is to rid the steam of entrained water. The storage vessel *B* is always kept full, receiving its supply through the well chamber at the bottom, which insures an even distribution and prevents coning or boring of the water. The accumulator is fitted with an auxiliary live-steam supply, and it is usual to install an oil separator between the engine and the steam inlet.

SCHWARZ ACCUMULATOR

Another type of accumulator, the Schwarz, is shown in Fig. 5. Its principle is similar to that of the one previously described but it possesses some interesting and distinctive features. The exhaust steam, after passing through an oil separator, enters the accumulator at the upper inlet on the right-hand side. It then flows downward through a duct formed by a partition in the outer cas-

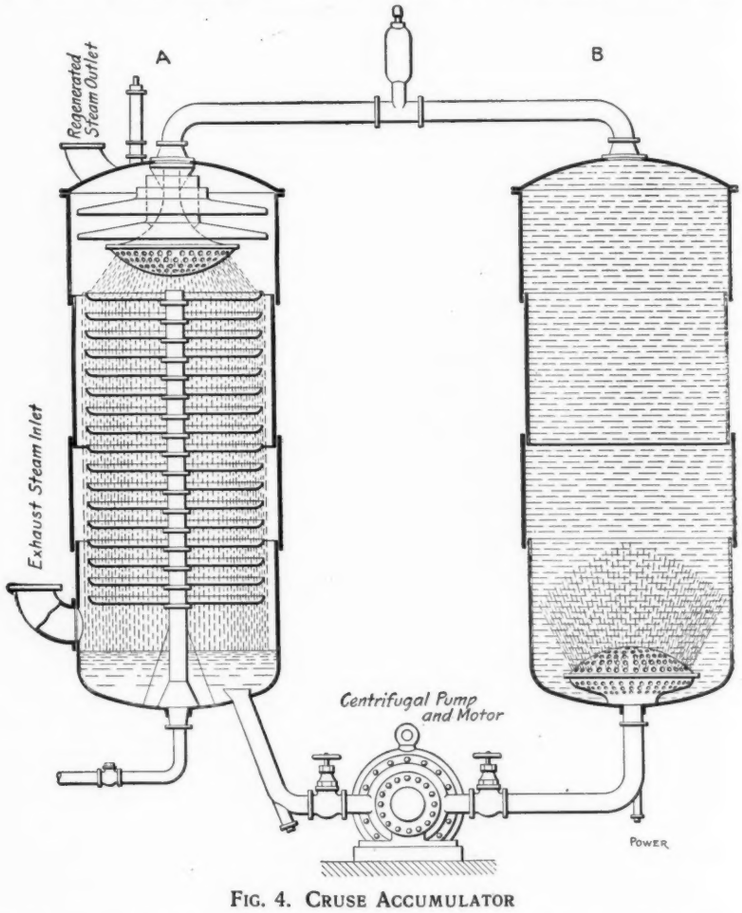


FIG. 4. CRUSE ACCUMULATOR

ing, and changing its direction at the bottom passes upward through the drain chambers and out to the turbine at the top. The interior arrangements shown consist of a number of chambers with perforated bottoms on which stand irrigation tubes. Under each of these cham-

bers are placed gratings, which spread the water forced round by the circulating pump and turn it into a shower which meets the steam and mixes intimately with it. The change of heat is rapid and efficient, owing to the close contact of the water and steam.

When an excess of steam is exhausted into the accumulator the pressure rises; but the difference in temperature between the steam and water is equalized by part of the steam being condensed; the pressure therefore falls and the water acquires a further store of heat. When, on the other hand, the supply of exhaust steam falls short the pressure drops proportionately; but as the temperature of the water is then higher than that of the incoming steam the water evaporates, and by supplying steam keeps

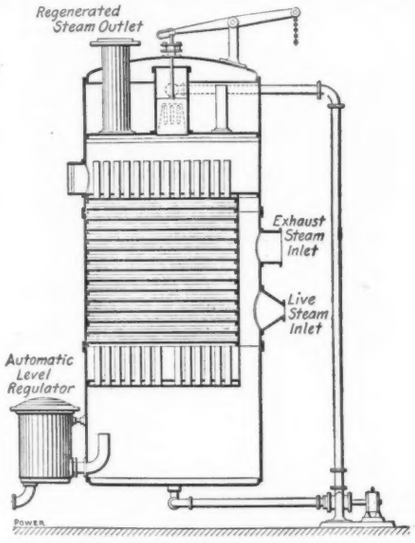


FIG. 5. SCHWARZ ACCUMULATOR

up the pressure. The accumulator is fitted with an automatic live-steam valve for maintaining the pressure when the quantity of exhaust steam falls short. There is also a safety valve for dealing with overpressure and an automatic draining apparatus for removing the surplus water of condensation.

An interesting feature of this type of accumulator is the method by which the volume of water is regulated in accordance with the requirements of the varying volume of steam. The action depends upon the pressure in the accumulator. Should this rise above a predetermined limit, the valve shown in the top of the steam chamber opens automatically and the water stored in the upper chamber flows into the lower until the pressure is equalized. This is in itself a material advantage, but it has the additional virtue of reducing to a minimum the power required by the circulating pump.

Thirty new electrical enterprises, including both hydro-electric and steam power, are contemplated in the United Kingdom.

To Engineers of Isolated Plants

BY HENRY D. JACKSON

Much has been written recently regarding the central station taking over so many isolated plants, and numerous engineers have said that an isolated plant could not compete with a central station, and *vice versa*.

The situation will not be cleared up until the isolated-plant engineers begin the keeping of accurate power-cost records. There are a large number of isolated plants in which the engineers are given every opportunity to obtain accurate and reliable power-cost figures, and in many cases engineers take advantage of their opportunity. Where this is not done it is but natural that the plant owner should consider that his plant is not doing as well as it might under purchased power, because the sales agent of the power company can hand him figures concerning his power costs which he is absolutely unable to refute, owing to the lack of interest taken in this matter by his engineer.

In many plants no facilities are given to engineers for obtaining records, and the engineer frequently feels that records are of no avail. There is, however, an opportunity open to the engineer in all of the isolated plants to educate the owner or manager to the value of records, and no plant is so small that it will not pay the engineer to keep records if only for his own satisfaction. It may be that these records are not even approximately exact, but they can be made comparative, and show from month to month or week to week what the comparative cost of power has been.

It is not absolutely necessary to weigh the water or the coal to get comparative records. If the engineer finds out approximately how much water he evaporates for a certain quantity of coal every day, and notes what machinery is in operation, keeping an accurate record of the amount of oil, waste, supplies, etc., used, he can hand in from day to day records which may be comparative. Then it is natural to assume that the owner or manager will want to know what these figures represent, thus giving the engineer a chance to bring forward arguments showing the necessity for scales for weighing the coal, some method of keeping track of the water. Having started in a small way and proving his case—which he may readily do by showing that during a certain period coal having a certain price would evaporate only a certain amount of water, whereas other coal at a higher price would evaporate more water in proportion to this price than the low-priced coal, thereby proving the value of the high-priced coal—the owner will see the value of such records and perhaps ask if there is not an opportunity for keeping still more records and with more accuracy.

It is also worth while for the engineer in the small plants who may not have an indicator to get some friend or associate who may have an indicator to indicate his engines now and then, thus determining what is the condition of the valves and the load. By taking indicator diagrams under various conditions of load, the engineer will be enabled to obtain an approximate idea as to what the load of his engine will be at other times by finding out what machinery is in operation, and enable him to at least roughly figure out the amount of coal and water used per horsepower-hour during the day. He will then gradually accumulate information that will aid him in refuting the claims of the central-station men.

It would also be a comparatively easy matter for the engineer to obtain fairly accurate figures regarding the cost of the engines, the boilers and the plant, so as to determine the fixed charges on the plant. He must know the labor charges; and these, with the fixed charges and cost of coal, water and supplies, will give the total cost of power. Then, knowing the power required, he can give the cost per horsepower-hour, which can be readily reduced to cost per kilowatt-hour in order to make a comparison with the cost of purchased power.

In the case of purchasing power the total power supplied at the switchboard must be figured; that is, say, if a plant requires a certain power at the motors, there is always a loss between the switchboard and the motors, depending upon the size of the motors, this being the loss of power in converting from electric into mechanical power. This will vary from 70 to 85 per cent., according to the size and the type of the motor.

To this power cost should also be added the additional interest, maintenance and depreciation charges due to the motor installation, and from this should be taken the interest on whatever may be obtained from the sale of the discarded apparatus. It should be noted, however, that in making the change the interest on the cost of discarded apparatus, minus the amount received for it, will go on just the same during purchased power, and, therefore, should be added to it.

The whole situation is to a large extent in the hands of the isolated-plant engineer. If he wants to hold his job, it is up to him to show that he is worth it; if he is not, he is bound to lose his job. By showing a live interest in the plant, the engineer can prove to the manufacturer that he is quite as important as any other man in his employ covering a department of the same value, and he will gradually gain the confidence of his employer, get an increased salary and rise in his vocation.

Management of Steam Power Plants

Suggestions as to the maintenance and economical operation of steam plants.

The requisites of a competent engineer and the latter's relation to the employer.

Under the auspices of the general committee of the combined associations of Manhattan and Bronx, N. A. S. E., a very successful meeting was held at the Broadway Central Hotel on the evening of Apr. 3. The meeting formed part of a general program being carried out by the committee for interesting the employer or manager in matters pertaining to the plant operation and for bringing him into closer touch with the engineer. That the employers have responded enthusiastically to this idea was evinced by their large representation at the meeting.

The speaker of the evening was Prof. E. V. Lallier, who talked upon "The Management of Steam Power Plants." Without entering into technicalities, he treated the subject from both the physical and the business aspects, pointing out how economy is dependent both upon the physical condition of the apparatus and upon its intelligent and efficient operation. While a plant should not be hampered by shortsighted finance, on the other hand, it should not be carelessly granted expenditures, but only after careful consideration has shown that such expenditures may be expected to produce the desired results.

It was pointed out that an engineer besides being practical, must be to a certain extent theoretical, so as to be capable of reasoning out engineering problems and applying the results to the plant in his charge. In addition to this he should possess business ability, be familiar with costs and capable of analyzing the various branches of his department with regard to their relations to each other, so as to keep accurate records and make complete reports. In this connection Prof. Lallier drew attention to the necessity for the engineer, who is held responsible for the efficiency of the plant, to know the cost of supplies and to be consulted as to the quality of the material purchased, so that the employer may not only profit by the engineer's advice and experience but that the latter may operate his plant more intelligently. Unfortunately, supplies are frequently purchased by some office man wholly upon the merits of the price quoted without regard to their fitness for the service required.

Concerning the physical features of the plant itself, Prof. Lallier's remarks were in part as follows:

The apparatus in too many plants is installed without due regard to accessibility. For instance, when a pump rod is to be removed, instead of meaning an hour or two of work, it necessitates moving the pump, breaking the connections and involving much unnecessary expense. Again, many boilers are placed so close to the ceiling that any repairs to the piping or valves above them cost at least twice as much as they should, due to working in a restricted space.

Good ventilation and plenty of light are also necessary. These are not only aids to health, but a light plant is usually kept clean.

Another necessity is a well ordered storeroom which as a time-saver will more than pay for the space utilized.

The boilers should be of such size as to readily carry the normal load and still have some reserve capacity. A spare boiler should be provided, not only to permit of the usual cleaning but also so that the regular operation of the plant will not be interfered with, should a breakdown occur. Where the load is variable the water-tube type of boiler is perhaps preferable on account of the readiness with which it responds to an increased demand for steam, but for the smaller plant, or one having a steady load, the fire-tube type is usually best fitted, for it requires less constant supervision.

Manual regulation of the draft should not be permitted, as this is necessarily irregular in application and is wasteful of fuel. With an automatic damper regulator the air supply is maintained within very close limits.

Too much care cannot be given to the condition of the feed valves, safety valves, steam gages, and particularly the blowoff valves. The latter are often placed in a more or less inaccessible place and an undiscovered leak will often prove an expensive matter.

Another prolific cause of waste is leaky traps; such a condition permitting a small but continuous flow of steam which is difficult to detect except by constant vigilance and checking up the results.

Regarding the accumulation of scale in boilers, it may be remarked that a layer $\frac{1}{16}$ in. thick may cause a loss as high as 20 per cent. of the fuel and a layer $\frac{1}{8}$ in. thick, a loss of nearly 30 per cent. Scale to some extent is an unavoidable evil, but too much of it is not unavoidable.

The burning of fuel is a very important matter, as the heat losses, comparatively large in any case, may easily be increased by improper firing, and by grates and furnaces unsuited to the work. The furnace should have ample combustion space and should be able to burn the maximum amount of fuel under unfavorable conditions of draft. The grates must be placed the correct distance from the boiler to care for the kind of fuel used and should have air spaces proportioned to the quality of the coal.

For large sizes of anthracite almost any average grate and a fair draft will serve, but, of course, intelligent firing is required; the fire must be kept of an even thickness and watched to see that no thin or dead spots occur. If the bed of coal is too thin, an excessive amount of air will pass through, whereas, if it is too thick, some of the carbon will be burned to carbon monoxide only, instead of to carbon dioxide, thus involving a waste of heat. With the finer sizes of anthracite a better draft is required and a thinner fire must be carried. This requires closer attention and more frequent cleaning.

It may be desirable to burn bituminous coal, but with the ordinary methods of hand firing, in addition to the fact that in New York City most of the furnaces are built for anthracite, it is difficult to obtain economy without exercising care in handling the fuel. In some plants the hard and soft coals are mixed, but with varying results, due largely to the methods of firing.

Another important factor affecting the operation of a plant is the proper insulation of pipes. For instance, recently a steam pipe 60 ft. long was subjected to a test and the steam was found to contain 31 per cent. of moisture; after covering with an efficient heat-insulating material this moisture was reduced to 3.6 per cent.

Various materials are available for this purpose, among the best of which are hair felt, slag wool, magnesia and asbestos. Hair felt, while an excellent nonconductor, must be protected from actual contact with highly heated pipes to prevent it from charring. On the other hand, slag wool has the advantage of being fireproof. A mixture with asbestos as a base is largely used with good effect and is supplied in convenient form for application. Water should not be permitted to drip on the pipe covering, neither should a leak, however small, be allowed to continue, for in addition to the loss due to the escaping steam, a wet covering readily becomes a very poor insulator of heat.

A word may be said in regard to reclaiming oil. Cylinder oil, such as may be separated from the exhaust steam, is valueless as it holds in suspension finely divided particles of hard carbon which

will cause injury to any wearing surface, also its vitality, so to speak, has been injured by the heat to which it has been subjected. On the other hand, the oil which has run through the comparatively cool bearings may be reclaimed and filtered in order to cleanse it of any dirt, and mixed with some fresh oil it may be used again.

Supplies and accessories should be purchased with intelligence and discrimination. Some time ago the daily papers had much to say about a five-foot book shelf of literature; the speaker believed that every engineer should have in his engine room a five-foot shelf of catalogs covering subjects pertaining to his calling and that he should become familiar with their contents. Many catalogs are extremely valuable on account of the rules and formulas they contain, also the descriptions of the articles sold and instructions for their use.

When anything for the plant is required, the engineer should ascertain as to the articles best suited to his requirements; he should then obtain the best prices and discounts possible. If he is not already familiar with the particular article he should visit some plant in which it is used, after which the purchase should depend strictly upon the merits of the article selected, for the price is not always an indication of its value for a given purpose.

A neat and compact method of keeping track of the cost of the various materials purchased is a small card index. The very fact of having a record of the supplies will enable the engineer to learn what kind and quantities will be required for a month to come; consequently he may send in a requisition covering everything required for the coming month and thereby avoid much delay and friction.

FIG. 1. CHUTE IN POSITION TO DELIVER ASH TO WAITING WAGON

Jeffrey Ash Elevator

One of the problems confronting engineers of office buildings, hotels, etc., in city districts is the removal of the ash refuse from the boiler plant. Hoisting ashes in cans through a manhole in the sidewalk by means of makeshift devices is slow, laborious work and is not liable to improve the temper of the tenants or guests.

In Fig. 1 is shown a Jeffrey telescopic ash elevator which is installed at the Astor Hotel, New York City. The photograph shows the elevator raised above the sidewalk, also the method of discharging the ashes into the ash wagon drawn up at the curbing. This elevator has a capacity of 7 tons per hour. Fig. 2 shows details of the elevator which contains 160 ft. of chain used in two equal strands, and 46 malleable-iron buckets each 6x10 in. in size.

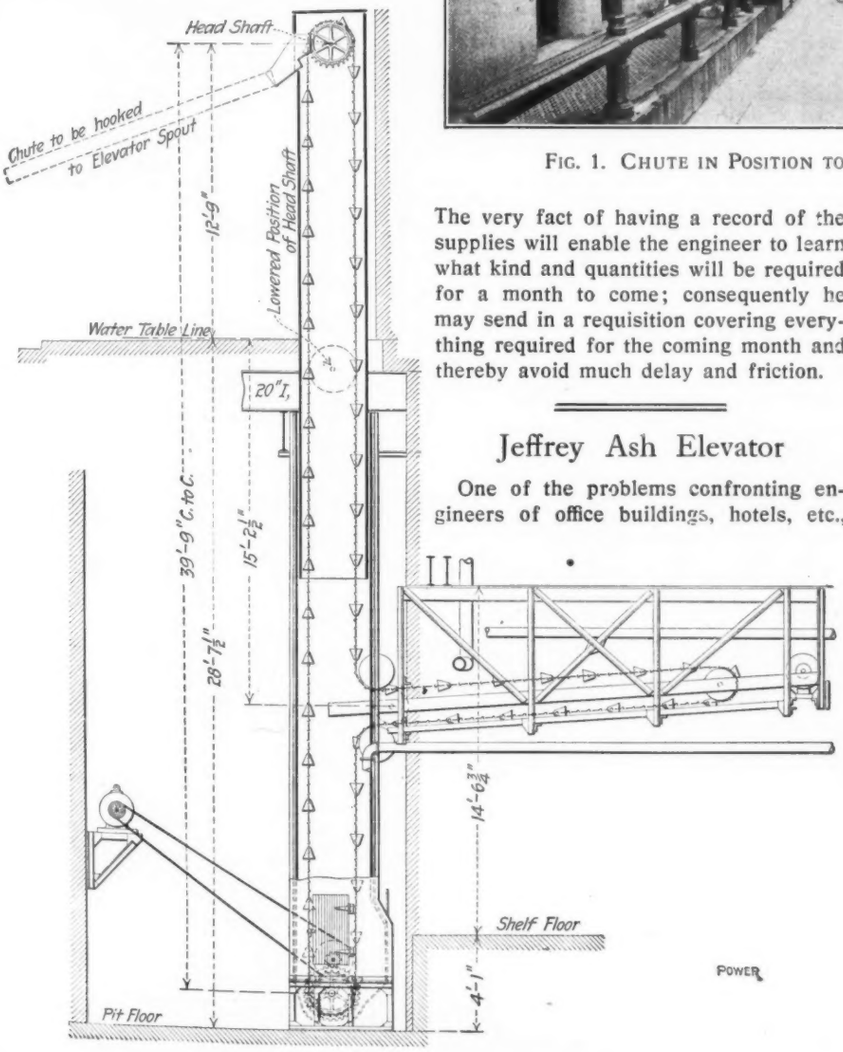


FIG. 2. ASH ELEVATOR IN DETAIL

When ashes are to be taken from the boiler room, which in this instance is by means of an overhead trolley, they are discharged into a hopper which is located at the lower portion of Fig. 2. The ashes are brought down through a passageway and are then elevated by the buckets to the ash-discharge chute and carted away.

When the elevator is not in use the buckets and chain are drawn to the horizontal position shown in Fig. 2, but when ashes are to be elevated, which is usually done late at night or early in the morning, the head of the elevator is hoisted to its extended position from the point shown by the dotted circle just below the street level. The horizontal chain and buckets are drawn into the shaft until the compensating pulley assumes the position shown by the dotted circle between the horizontal buckets. The illustration indicates the two extreme positions of the elevator when in and out of use. When the chute is not in use, it is droped beside the elevator casing.

Bending Sand-Filled Pipe

By J. E. Terman

Fred was a good blacksmith, but he lacked foresight. He worked for a master mechanic who had advanced notions in regard to piping, and who insisted that all elbows be done away with as far as possible. Therefore bent pipe had to be used in their stead, and the pipe-bending jobs fell to the blacksmith.

On the large pipes, Fred would always make a good job, for he would take many short heats and make a nice, smooth bend, but on the small-sized pipe, he got impatient and would try to bend it too quickly; the result was that the pipe was flat on the curve or otherwise deformed.

One day the master mechanic was guying Fred about his pipe bends, and told him that it was customary to fill the pipe with sand to prevent it being flattened while being bent. The blacksmith thought this a capital idea, and the next time a 2-in. pipe was to be bent, he told his trusty helper to fill it with sand.

It happened that a sandy road ran near the shop, and the helper took the piece of pipe, which was about 12 ft. long, out to this road and rammed it full of wet sand. The job was pronounced satisfactory and the pipe was put on the forge to heat. While the helper worked, Fred stood in the doorway whistling his favorite tune and wondering why he had never thought of so simple a thing as sand, himself.

Suddenly there was a bang! and the pipe exploded. The tightly packed wet sand in the pipe had prevented the escape of the steam formed at the heated section.

The master mechanic thought it a great joke and told Fred that he ought to have had sense enough to use dry sand, and advised its use in the future. However, Fred had learned his lesson and thereafter refused to bend a piece of pipe that he could not look through.

Furnace for Burning Low Grade Fuel*

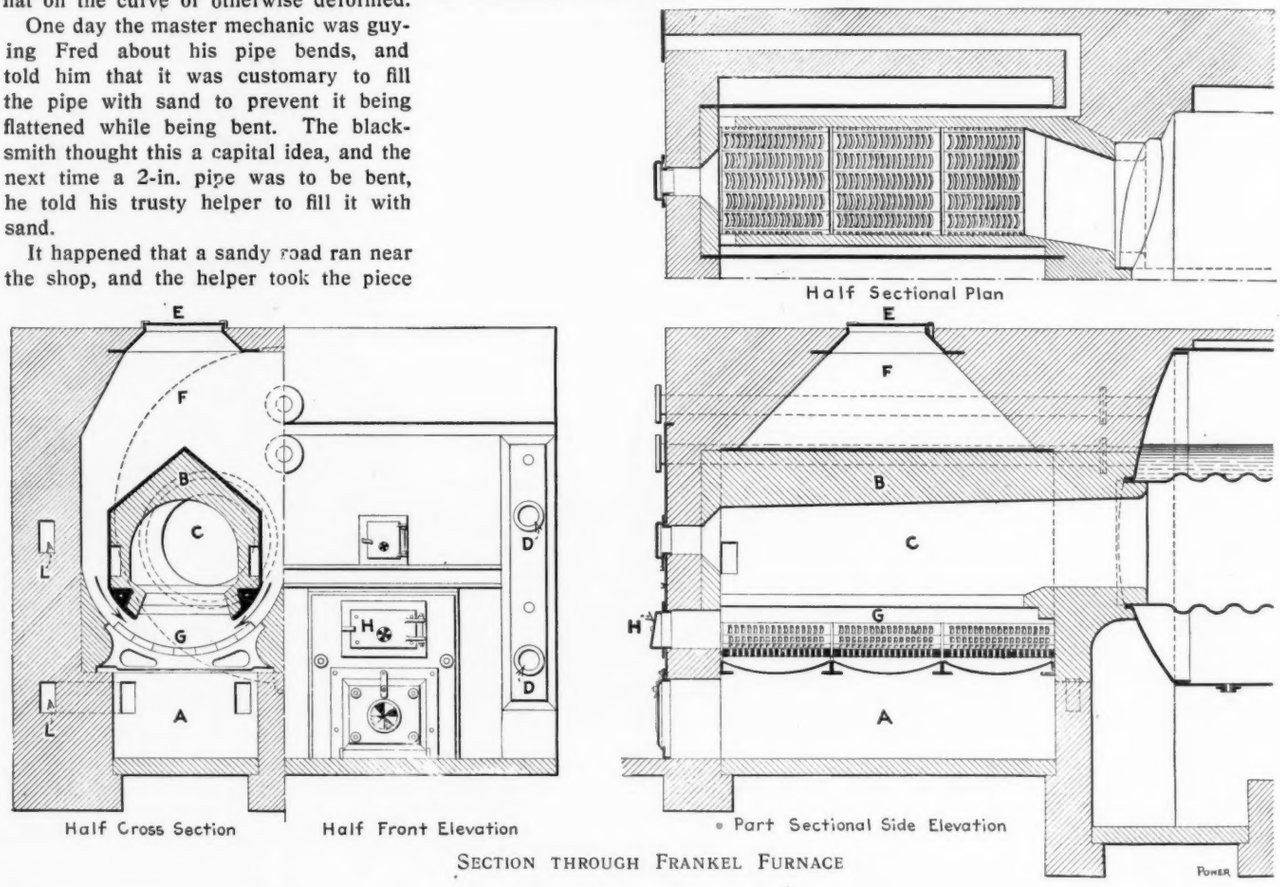
Good combustion in a furnace may be considered as dependent mainly upon the following factors:

1. The stoking must be regular; no part of the grate should be bare, and, as far as possible, an even layer of coal should be distributed over the grate.
2. Air for combustion must be supplied in the proper quantities.
3. The air must mix with the gases as intimately as possible.
4. A sufficiently high temperature must be produced and maintained continuously.

A furnace which apparently complies with these requirements and permits the economical use of low-grade coal is the so called Fränkel furnace, herein illustrated. Coal is fed from the top through the charging door *E* into the fuel space *F*. Here it surrounds the brickwork *B* and falls to the concave grate *G* as indicated by the arrows. The gases pass through the combustion chamber *C* and thence into the flues of the boiler. The brickwork surrounding the combustion chamber *C* is supported by hollow air-cooled brackets. The main combustion zone being over the middle part of the grate, the walls of the combustion chamber become highly heated; consequently, the fuel, which is generally very moist, is well dried in the fuel chamber. The greater part of the radiant heat is therefore utilized in drying and preparing the fuel, which is a distinct advantage in this furnace.

The air supply is obtained through the openings *L* in the brickwork, these leading from the front of the furnace through the hot brickwork to the back and return, opening both above and below the grate. The path of this air is shown plainly in the plan view; and in this way the air is highly heated before reaching the point at which it is needed for combustion. The draft is easily regulated by the circular dampers *D* located at the front of the furnace. For moderate service, these furnish sufficient air for combustion, but where the fire is forced it is advisable to also open the door of the ashpit.

The rate of combustion in this furnace is subject to no sudden variation. The masonry of the combustion chamber serves as a heat reservoir and always affords a constant temperature; the walls being of a refractory material, tend to keep the rate of combustion steady. For this reason, also, the fuel layer may be comparatively thick without the unburned gases escaping to the stack.



SECTION THROUGH FRANKEL FURNACE

*Translated from an article by A. Brüser in "Maschinenbau."

The grate may be cleaned or the clinkers removed by merely opening the door at the front of the furnace.

This furnace is available for any form or size of steam boiler and is especially suitable for burning low-grade fuels such as lignite. However, all sizes of coal may be burned from culm to nut as well as peat, tanbark, sawdust and refuse of all sorts.

The angle of charging should be suited to the fuel used. In cases where there are frequent variations in the size of the coal, the furnace is provided with an arrangement for stopping the fuel supply when necessary. The cast-iron brackets on which the brickwork is supported form a means for regulating the feed since the size of the opening between the grate and these brackets is arranged according to the size of the fuel and the width of the grate. If there should be a change in the size of fuel used, the grate, of course, can be raised or lowered to provide a proper opening.

The fuel is mechanically supplied through the firing door by an elevator, conveyor or other means.

Boiler Bracing

By A. D. Palmer

In a recent issue a subscriber asks the following question: "How many braces 1 sq.in. in cross-sectional area would it take to brace a boiler 60 in. in diameter, the steam pressure being 80 lb. and the top of the top row of tubes 5 in. above the center of the head?" I have seen the same question asked a number of times, and will therefore figure it out according to the method employed by the Massachusetts examiners.

In a 60-in. boiler, that part of the heads comprising a ring 3 in. from the shell is supported by the flange, and requires no bracing. The lower part of the head is supported by the tubes, the support extending 2 in. above them. Hence the area to be supported by the braces is a segment of a circle as indicated by the shaded portion of the accompanying sketch. To find the area of this segment, employ the formula

$$A = \frac{4 \times H^2}{3} \times \sqrt{\frac{2 \times R}{H}} = 0.608$$

where

A = Area in sq.in.;
H = Height of the segment;
R = Radius of boiler less 3 in.

Substituting in the formula

$$A = \frac{4 \times (20 \times 20)}{3} \times \sqrt{\frac{2 \times 27}{20}} - 0.608$$

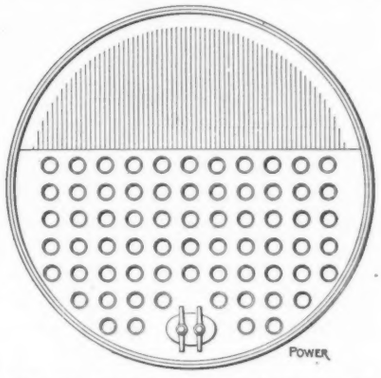
$$= 771 \text{ sq.in.}$$

Multiplying 771 by 80 gives 61,680 lb. as the total pressure upon the segment.

The allowable stress upon a wrought-iron brace of 1 in. diameter is 6000 lb.; hence,

$$61{,}680 \div 6000 = 12 \textit{ braces}$$

are required to brace the head. This number in a 60-in. boiler is too many, as the braces would be in the way when working in the boiler. It is better practice to use larger and fewer braces. For



Shaded Portion Shows Area to be Braced

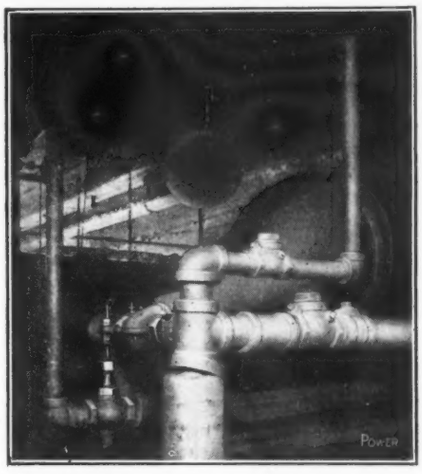
instance, the area of a 1½-in. brace is 1.767 in., and this multiplied by 6000 gives 10,602 lb. as the allowable stress in a 1½-in. brace.

$$61{,}680 \div 10{,}602 = 6 \textit{ braces}$$

which will leave much more working room.

First Bundy Trap

What is said to be the first Bundy steam trap ever installed is illustrated herewith. It was set up in the mill of the Champion Card & Glazed Paper Co., now a part of the Champion International Paper Co., East Pepperell, Mass. Installed in 1890 to take care of the drying coils used in drying paper, it has been in constant use for 22 years and it is probably the first tilting trap ever operated. The trap is 1½ in. in size and



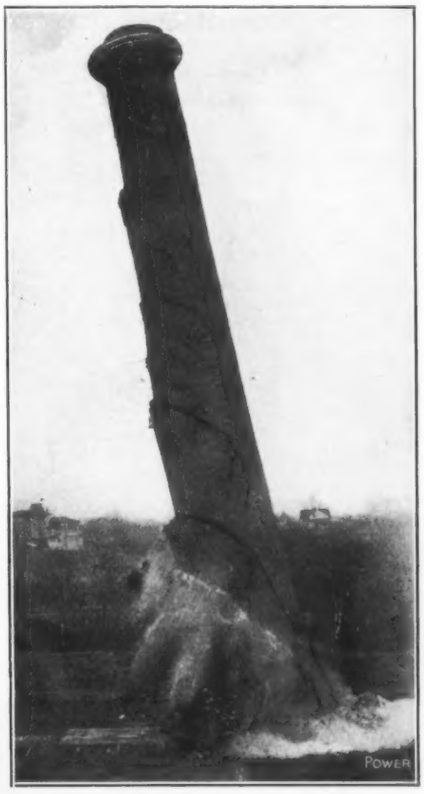
Trap in Use Over 22 Years

up to within a few weeks ago was filling and discharging regularly four times a minute.

This trap has handled during the past 22 years approximately 100,000 tons of water; it is still giving excellent service, and is apparently good for many more years of usefulness. During these years, it is said, the repairs have not exceeded $12.

Razing a Huge Chimney

The chimney shown in the accompanying photograph belonged to the abandoned licorice works in North Third St., Newark, N. J. It was the third largest in that city, being 22 ft. in diameter at the base and 183 ft. high. A 7-ton iron ring was mounted at the top. The chimney was built 20 years ago by the McAndrews-Forbes Co., the owners of the plant.



When the Fire Completed its Work

A contractor purchased it for the brick it contained. In razing the chimney it was necessary to have it fall in a certain direction to avoid damage to adjacent property. In preparing for its fall the brick were removed for about one-half its circumference, timber supports being used as the brick were taken out. When the supports were completed a large quantity of kerosene was poured over them and set on fire.

Aided by a heavy wind, the draft was very strong. It was an anxious 20 minutes before the wooden base gave way and the great chimney rocked to and fro and then fell.

The chimney fell within 100 ft. of its base. The cracks in the illustration clearly show the huge pieces into which the chimney broke. For the information and photograph we are indebted to the *Newark Evening News*.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Practical Points on Knife Switches

By A. G. Campbell

All knife switches made by reputable manufacturers are constructed in accordance with National Electrical Code requirements. This protects the buyer against very serious deficiencies, but it is advisable to inspect every switch carefully before it is installed, in order to avoid small annoyances.

Fig. 1 gives the names of knife-switch parts. The contacts between the break-jaws and the blades should be carefully inspected, as it is at these points that knife switches are most apt to give trouble by overheating.

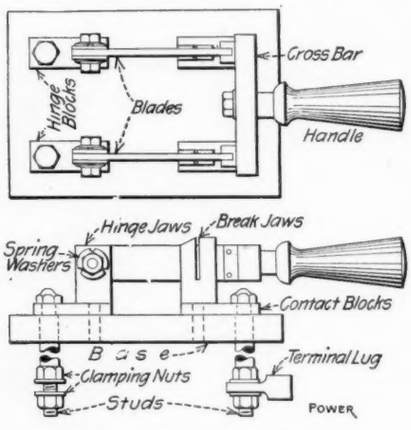
The contact between the hinge-jaw and the blade seldom affects the capacity of a switch, because it is under pressure from the hinge bolt and spring washers. The capacity of a switch is determined by its temperature rise. The code specifies a maximum rise in any part of 50 deg. F. at full load.

Considerable skill is required to effect a good contact or "fit" between break-jaws and blades. After a switch is assembled, the jaws are first bent into correct position either by hand or by driving a block of wood against the distorted portion with a hammer. Then they are "ground in" with vaseline and fine (FF) pumice stone.

Often the fit of a switch is reasonably good at the start, and merely working the blade in and out of the jaws by hand will grind it in. Before the grinding process is started, the portion of the blade that wipes the jaws should be daubed with the vaseline and pumice-stone compound. The abrasive not only grinds the contact to a fit but wears off the lacquer, which, if it remained, might cause bad electrical contact. The surplus compound should be removed with a rag.

A test for good blade contact can be made by trying to insert a "feeler," which is a leaf of very thin steel, mica or paper, between the jaws and blade at the corners and edges. About 0.001 to 0.004 in. is the right thickness for a feeler. An excellent feeler can be made by hammering down to a knife edge the edges of a strip of very thin metal possibly 4 in. long and ¾ in. wide. If the feeler slips in at any point, it is evident that the fit is poor at that point and the contact bad. Proper forming of the jaw will correct the difficulty. There have been cases where switches have been made to carry, without excessive temperature rise, currents 50 per cent. greater than their normal ratings by merely fitting the jaws accurately to their blades.

About 1000 amperes per square inch of copper cross-section and 50 to 75 amperes per square inch of sliding contact surface are usually allowed in designing switches. A switch that will carry 1000 amperes with 20 deg. temperature rise will carry probably 2000 amperes with about a 60-deg. rise. The radiation of heat from the switch increases more rapidly than does the rise in temperature, and as the heat generated varies as the square of the current, it is



A Double Pole Knife Switch

evident that the temperature rise will be somewhat less than proportional to the square of the current.

A switch will break about twice the voltage with alternating current that it will with direct current, the amperage being the same in both cases. The insurance code recognizes this and specifies that "for 100-ampere switches and larger, the spacings for 250 volts with direct current are also approved for 500 volts alternating current."

The voltage drop between the terminal blocks of a good switch should not exceed about 12 millivolts per blade with full-load current.

Quick-break switches have an auxiliary breaking arrangement, actuated by a spring, making it difficult to draw an arc even if the switch is opened slowly. In general, the quick-break attachment is relatively delicate and apt to get out of order. Where feasible, it is always better to use a switch without a quick-break attachment.

Single-throw knife switches should be so mounted that gravity will tend to open rather than to close them. Double-throw switches can be mounted horizontally, but often when so mounted it is inconvenient to make connections to them, and they do not work in well with many switchboard arrangements; hence they are often mounted vertically and an insulating guard, possibly of wood, is arranged so that it may be slipped over the jaws on the lower terminals of the switch to prevent accidental contact.

Usually it is best to connect a switch so that the break-jaws will be "alive" and the blades "dead" when the switch is open. The blades expose more surface and extend further than do the jaws; hence they are more liable to accidental contact and short-circuits than are the jaws.

Inclosed snap switches are usually preferable to knife switches where it is feasible to use them. Snap switches can be obtained for breaking currents as great as 30 amperes at 250 volts. The unskilled person in opening and closing a knife switch is apt to draw an arc between the contacts and in closing the switch to enter the blades only part way in the jaws; both practices will pit the metal and ultimately ruin the switch. This condition cannot occur with a good snap switch. Only indicating switches should be installed.

Power Factor Chart for Three-Phase Circuits

By Charles A. Phillips

The accompanying chart shows the relation between the kilovolt-amperes per phase, the power factor and the total kilowatts in a balanced three-phase circuit. Three pairs of scales are given in order to obtain a wide range without making the chart of unwieldy size. In using it, the two scales of the same letter must be used; for example, if the kilovolt-amperes are located in the horizontal *A* scale, the corresponding kilowatts will be found in the vertical *A* scale.

The method of using the chart is almost obvious from inspection of it. If the kilovolt-amperes and the kilowatts are both known, the number on the diagonal line which cuts the intersection

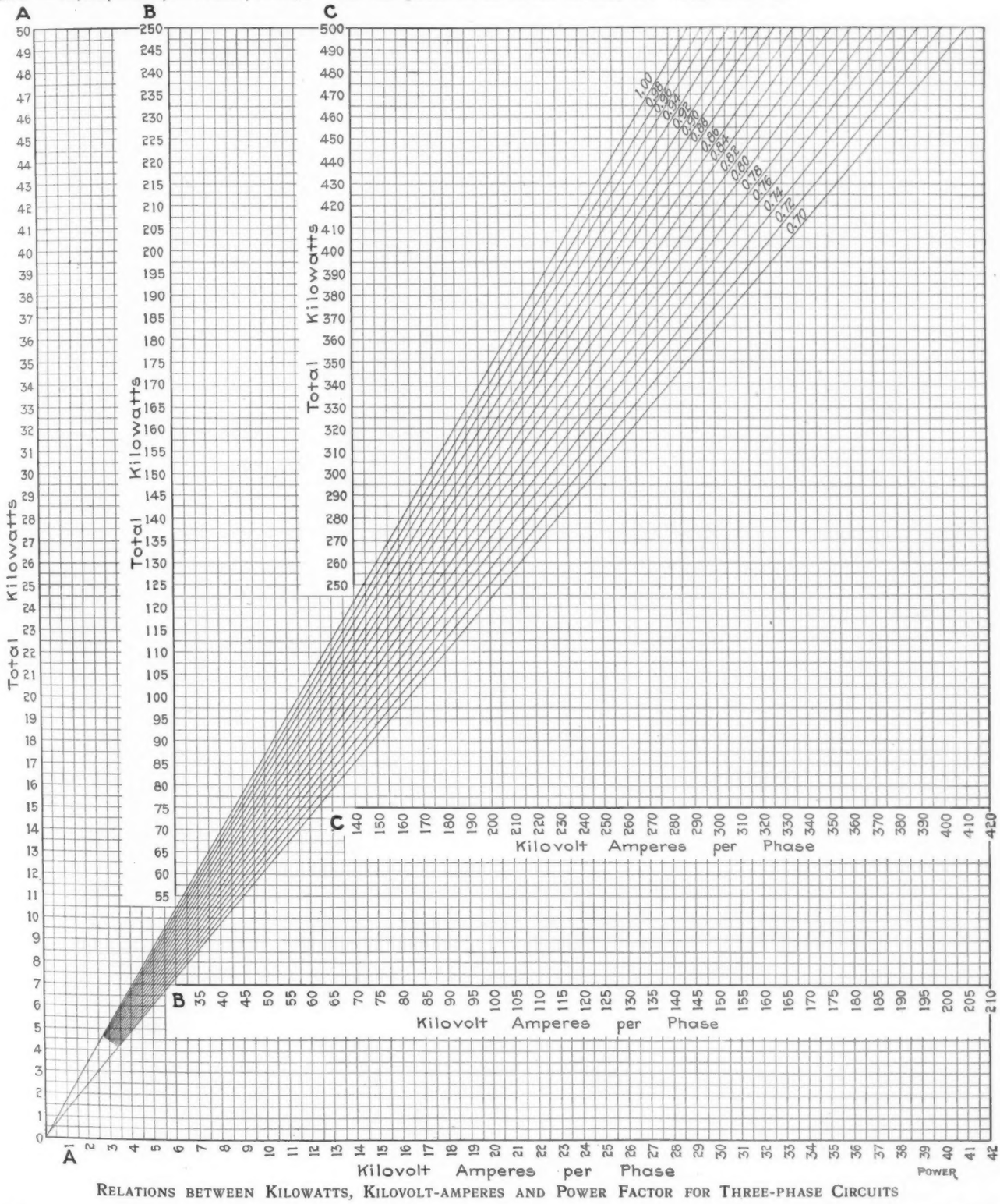
of the kilowatt and kilovolt-ampere lines will be the power factor.

Suppose, for example, that a 2300-volt circuit is carrying 15 amperes per leg; the volt-amperes per phase will be 15 × 2300 = 34,500, which, of course, is 34½ kilovolt-amperes. Also suppose that the kilowattmeter shows 43 kw. Tracing to the right from 43 kw. in the *A* scale and up from 34½ kilovolt-amperes in the corresponding bottom scale, these two lines will meet on the diagonal line marked 0.72; therefore, the power factor of the circuit is 72 per cent.

Again, suppose that a 500-volt motor circuit was taking 250 amperes per leg and the power-factor meter showed 88 per cent.; how many kilowatts would the circuit be taking?

The volt-amperes being 500 × 250 = 125,000, the kilovolt-amperes are 125. This number will be found in scale *B* at the bottom of the chart; tracing up from that point to the 0.88 power-factor line and then straight across to scale *B* at the left, the number 190 will be found there; the power in the circuit, therefore, is 190 kw.

If the switchboard be equipped with a voltmeter, ammeters, a wattmeter and a power factor indicator, the chart will be found useful in checking the accuracy of the meters with respect to each other.



RELATIONS BETWEEN KILOWATTS, KILOVOLT-AMPERES AND POWER FACTOR FOR THREE-PHASE CIRCUITS

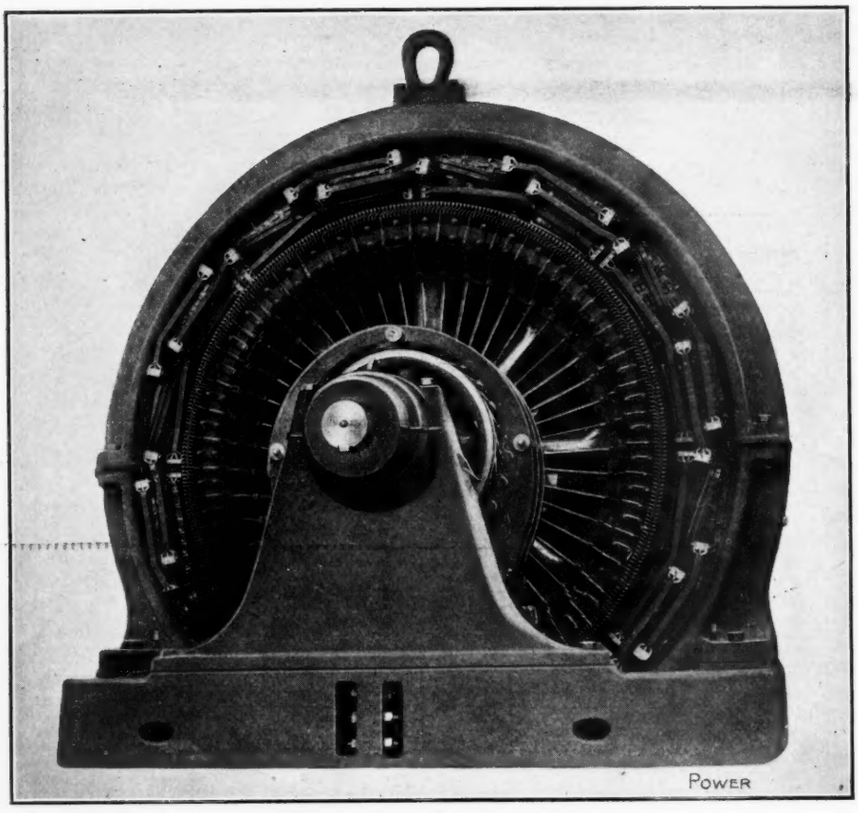
A 7500-Kw. Rotary Converter

Real estate in all large cities is so expensive that it is imperative for public-service companies to use every square foot of substation-floor area most effectively. In rotary-converter substations a very large portion of the requisite floor space is occupied by the converters, and much study has been given by electrical designers to the matter of increasing the converter capacity per square foot of floor space.

When some two years ago two 25-cycle, six-phase, 600-volt, 3000-kw. Westinghouse rotary converters were purchased by the Interborough Rapid Transit Co., New York, and installed in the space formerly occupied by two 1500-kw. converters of similar characteristics, it was believed that just about the maximum point of concentration had been reached. The output of the station in which they were installed was doubled without increasing the floor area. Now comes the announcement that a 7500-kw. Westinghouse interpole rotary converter (600 volts, six phases and 25 cycles) just installed in the Ninety-sixth St. substation of the Interborough company occupies but a trifle more floor space than was occupied by each of the 3000-kw. machines which were previously the standard.

Although guaranteed to take care of load swings, such as are inherent to heavy railway service, up to 7500 kw., the machine is said to have successfully handled swings one-third greater than its rating, or of 10,000 kw.

The accompanying picture gives a view of the converter on the alternating-current side, showing clearly the equalizer connections and the method of connecting the various field-magnet coils.



A 7500-KILOWATT ROTARY CONVERTER

LETTERS

Unexpected Wattmeter Readings

I wish to submit to practical readers of POWER the following question in polyphase power measurement:

In measuring the load of a 600-hp. three-phase synchronous motor, supplied with current at 30 cycles and 2200 volts, I had two wattmeters connected as shown by the accompanying diagrams. No. 1 meter is a Westinghouse graphic polyphase wattmeter rated at 5 amperes and 100 volts; No. 2 is a G. E. polyphase portable wattmeter rated at 5 and 10 amperes at 150 volts. Both meters when compared checked very closely.

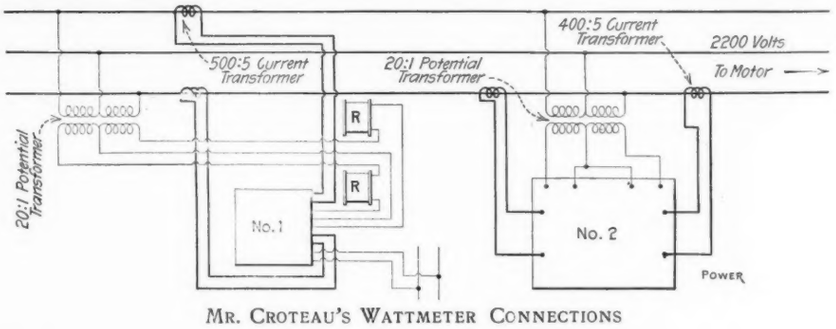
As I was checking the power factor of the motor I told the motor attendant to increase the excitation current of the machine, and as soon as this was done I noticed that meter No. 1 was recording about half load and meter No. 2 full load. Why should this be so?

In the case of a load of exactly 50 per cent. power factor, using two single-phase wattmeters, one meter will register 0 and the other meter will register the total power, the sum of the two readings being the correct power. But when the power factor becomes less than 50 per cent., one meter registers more than the total power and the other registers backward an amount sufficient to make the total indicated power correct.

In my case, as I am using two polyphase wattmeters properly connected, the registration should be correct under all conditions of load.

J. A. CROTEAU.

Thetford Mines, P. Q., Canada.



MR. CROTEAU'S WATTMETER CONNECTIONS

Arc Lamp Operation

In the section of the Catechism of Electricity which appeared in the issue of Feb. 13, the answer to question No. 1193 states that the upper carbon of an open arc lamp does not actually burn more rapidly than the lower carbon, but wastes away more rapidly because of the transfer of carbon particles from the positive to the negative tip. This reply is partly incorrect; the upper carbon tip actually burns more rapidly than the lower because a greater portion of it is heated to a high temperature and oxidation is therefore more rapid. The carrying of particles from positive to negative is slight.

The answer to question 1198 is somewhat misleading, though correct. The candlepower ratings are never realized in actual illumination; they are merely nominal. The actual mean spherical candlepower is about 400 in an open lamp and 150 to 300 in inclosed arcs, according to the kind of current used and its value; it is less with alternating than with direct current.

Cleveland, Ohio. C. W. HILL.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

The Diesel Engine Ship "Selandia"

The largest oil-power vessel thus far built has just been put through a series of trial runs which are said to have more than vindicated the predictions made for her. This vessel, named the "Selandia," is the first of three that are being built by a Copenhagen firm for service in the Far East; the second of the three, the "Jutlandia," was announced recently. They are twin-screw ships.

The hull is 370 ft. long between perpendiculars and 53 ft. beam, with a depth molded of 30 ft. The ship has been designed to carry a dead-weight cargo of about 7400 tons at a service speed of 12 knots. Extensive accommodation is provided for a large number of passengers in a deckhouse amidships. This passenger accommodation is of a high class, with cabins and bathrooms *en suite*, and the ships will be regarded with special interest, since they are the first oil-driven ships built for regular passenger service.

The Engines

The feature, of course, is the machinery. The engines are designed to work on the four-stroke cycle and each of the two shafts is driven by an eight-cylinder Diesel engine; the diameter of the cylinders is 20⅞ in., and the stroke 28¾ in. The normal speed is 140 r.p.m., at which each engine develops 1250 shaft horsepower. These engines have cross-heads as in ordinary marine steam practice, but the crank pit is completely closed in.

There are also two auxiliary Diesel engines of 200 hp., which drive the lubricating, cooling-water, sanitary and bilge pumps, the refrigerating plant, etc., in addition to a dynamo supplying electricity for lighting, fan driving, winch operating, air compressing, etc. The consumption of oil was measured on the trials and found to be 166 grams, which equals 0.366 lb., per indicated horsepower-hour; this included the oil used by the auxiliary engines, which during the trial were developing about 70 indicated horsepower. The mechanical efficiency was found to be 84.5 per cent.

Each of the engines is divided into two sections of four cylinders each, as indicated in the general view, Fig. 1. The cranks of each four-cylinder group are in pairs 180 deg. apart; each complete group of four cranks is set 90 deg. from the four cranks of the other group. This arrangement gives a diagram of turning moments the maximum of which is about 1.35 times the mean, which indicates that vibration will not trouble the passengers. It may be pointed out that this is a better figure than can be obtained from a four-cylinder two-stroke engine, which is regarded so often as the equivalent of an eight-cylinder four-stroke engine.

The cylinders are mounted on a massive casing and through-bolted to the base. This casing is in four sections and

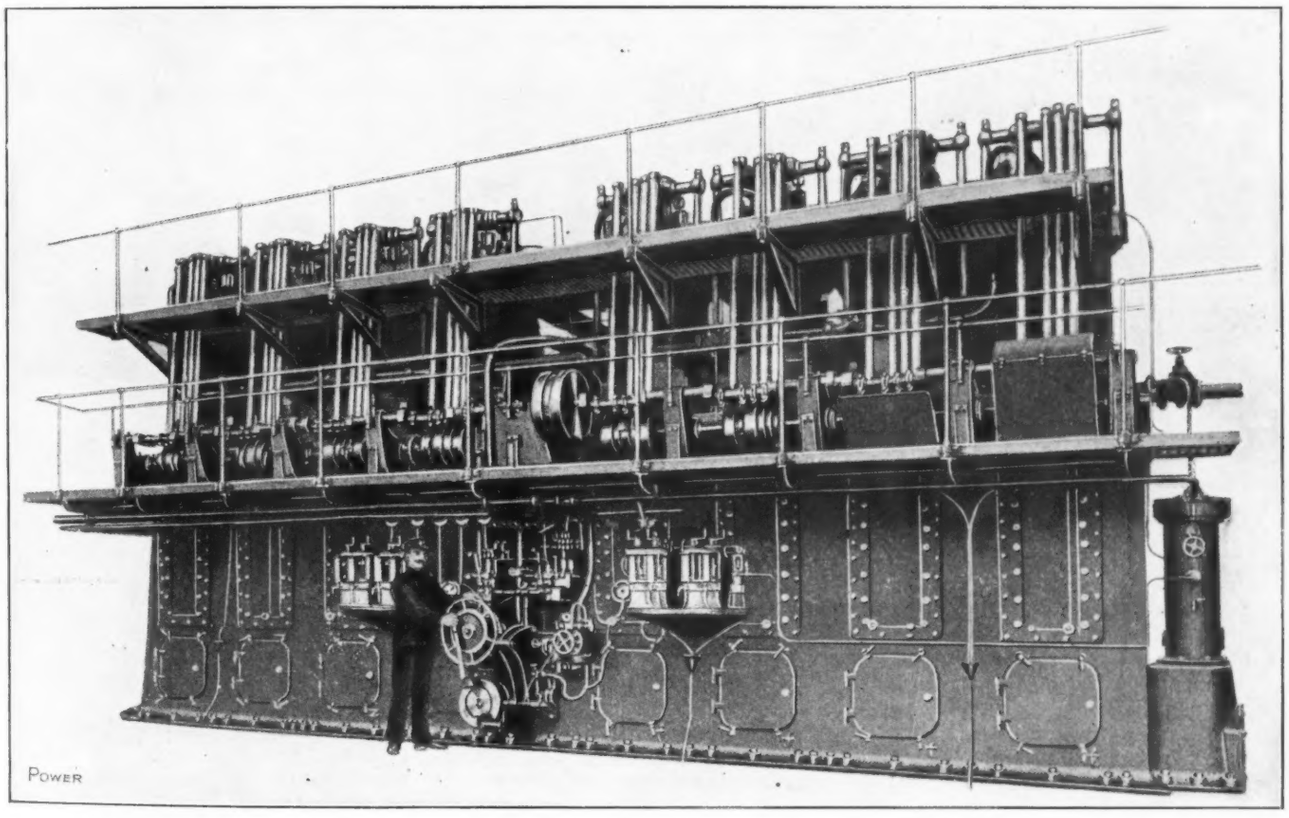


FIG. 1. ONE OF THE ENGINES OF THE SHIP "SELANDIA"

the base is in two. At back and front are doors. At the back the doors are deep and are hinged, the fastenings being dogs held down by flynuts. There is a door opposite each crosshead, besides a middle door giving access to the camshaft gear and rod drive. On the front there is below each cylinder a door fastened by studs. These doors carry the water-cooled crosshead guides. Below each of these doors is a smaller hinged door closed by flynuts.

All the valve-gear is on the front of the engine. The valves are operated by overhead rocking arms supported by separate mandrels, carried in two standards mounted on lugs at the sides of the cylinders. Heavy brackets bolted to the top of the crank casing carry the bearings of the camshaft and also a layshaft. From the camshaft the motion is taken to the overhead rockers by stiff hollow push-rods.

The engines are started, of course, by compressed air; the air pressure is 300 lb. per square inch, and is maintained by a two-stage motor-driven compressor. Air is taken from the 300-lb. tank by another compressor driven from the forward end of the main engine shaft and compressed up to 800 or 900 lb. for use in injecting the oil into the cylinders.

Reverse Gear

Reversing is effected by sliding the camshaft longitudinally so as to bring another set of cams into alignment with the push-rod rollers. The accompanying sketch, Fig. 2, shows the arrangement of the camshaft drive. An intermediate short shaft *A* is geared to the crankshaft in the ratio of 2 to 3 and therefore runs at two-thirds crankshaft speed. Its motion is transmitted to a second short countershaft *B* by means of two connecting-rods coöperating with crankpins 90 deg. apart. The shaft *B* is geared to the camshaft *C* in the ratio of 3 to 4, bringing the speed of the camshaft down to one-half that of the crankshaft, as is the case in all four-stroke engines.

The method of sliding this shaft and disengaging the rollers from the cams to allow it to move is very ingenious, though it introduces a second layshaft along the front of the engine having eight long crankpins upon it. Each crankpin on this secondary or weighshaft *D*, Fig. 2, carries four short links, each attached to a pin on the foot of one of the push-rods, close to the roller, to hold the lower end of the rod in position while suspended from the rocker above. This weighshaft can be rotated through almost a complete revolution by a little compressed-air reversing engine on the starting platform, through a vertical shaft fitted with a worm gear with ball thrusts at each end, the arrangement being exactly like the barring-around gear of a steam engine, except that the weighshaft cannot make a complete revolution. It differs also in that in both ahead and in astern gear the cranks point inward toward the cylinders, the valve rods being thus held by the little links over the center of the camshaft, and so the rollers are in position to be operated by the cams.

The neutral or stop position is obtained by a half revolution of the weighshaft *D*. This makes the crank arms point outward from the cylinders, and the valve rods are therefore swung out clear of the cams and receive no motion from them. The sliding of the camshaft is then effected by the continued rotation of the weighshaft. A roller carried on a pin fixed in a sleeve fitted between two collars on the camshaft travels in a single incline cam path cut in the periphery of a cast-iron drum mounted on the weighshaft, shown in Fig. 2, and which can also be seen in the center of the weighshaft in the general view, Fig. 1,

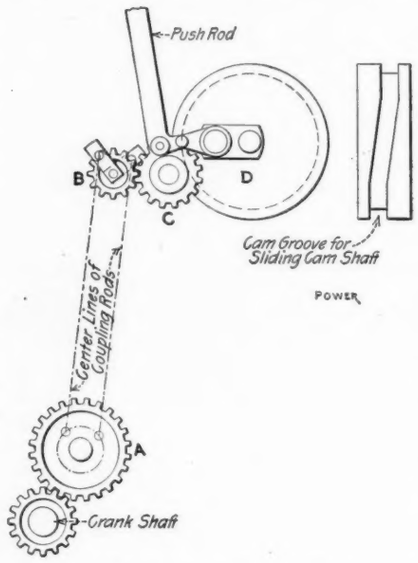


Fig. 2. Part of Valve Gear

the incline meeting the roller when the cranks near their outer position—that is, when the rollers are off the cams. Thus, as the weighshaft continues to revolve, the incline travels around and moves the pin and the camshaft longitudinally just far enough to shift one set of cams out of the line of the valve rods and put the other set in line. Continued rotation of the weighshaft swings the ends of the push rods back into alignment with the cams, this time, however, the reverse-motion cams. During the recent trial runs the change over from full speed ahead to full speed astern was effected in 10 sec.

General Control

There is one main starting lever, which has to be drawn to one extremity of its motion, called the neutral position, before the reversing engine can be started. In this position both the compressed air and the fuel are shut off from the main engines, and to this extent the arrangement is "fool-proof." The small reversing engine (reciprocating type), driven by 300 lb. compressed air, is then started, and rotates the weighshaft *D* to shift the camshaft into the required position, ahead or astern, as the case may be, and restore the push rods to the working positions, as just described. The details of the mechanism are such that the main lever cannot be shifted from the neutral position until the push rods have been replaced in alignment with the cams. Only when this has been done can the main lever be put into a central position, in which it enables the 300 lb. air supply to pass into the cylinder; this supply, being carried six-tenths of the stroke, gives facility for starting the engine irrespective of the position of the cranks.

When the engine has got under way with compressed air, the main lever is pushed still further over into the oil-supply position. The lever "gate" is provided with a notch at the front for the neutral position, another a third of the way along, for the compressed air for starting and reversing, while on the last third of the "gate" length there are numerous evenly divided notches for varying the volume of oil fuel supplied to the engine so as to vary the power developed. The operating lever is centrally mounted on the front of each engine, conforming closely to the handling appliance of the ordinary steam engine.

A small Aspinall governor is provided to cut off the fuel supply when the speed exceeds the normal, and thereby prevent racing if the propeller should lift out of water, as it easily may in rough weather. The governor has no control over the speed below this maximum point.

For the delivery of fuel to the injection valves there are two pumps on each main engine, each pump supplying four of the cylinders. From the pump the fuel is fed to a small box on the back of each cylinder, and in these boxes the pressures equalize themselves, so that all cylinders receive equal quantities. It would seem that a balance is made between the pressure behind the fuel and the air pressure in front of it to determine the quantity admitted for injection, according to engine speed. The regulating handle lifts the suction valves of the fuel pumps in similar style to that adopted on many types of Diesel engines, and thus varies the pump charge. This appears to reduce the quantity of fuel that will force itself against the air pressure into the injection-valve chamber. Each fuel box has a regulating valve for adjustment. To prime the fuel pipes there is a hand pump for each group of four cylinders. A bypass can be opened on each injection valve to release the air from the fuel pipes, which, after filling, overflow into drains which extend down the back of the engine.

A special feature of the injection valves is their inward travel. Instead of using the familiar needle valves, opened outward to permit the charge of fuel to be atomized into the cylinder, the builders have adopted a mushroom-head valve, which opens downward into the cylinder. The usual atomizing disks are retained, so that the fuel enters the combustion chamber in the same state as if it were passing a needle valve. The mushroom head, however, spreads the fuel around the combustion space.

Automatic Devices

In order to prevent dangerous pressures arising inadvertently in the cylinders there are relief valves to each combustion chamber, these being fitted into the sides of the cylinder heads. Furthermore, in order to prevent back pressure in the cylinders when reversing, a device is employed on all cylinders to relieve the pressures when the engine is stopped. This is effected by a trip-gear device on each exhaust-valve motion. Under the rocker of the valve is an upright bar pinned upon the cylinder cover, and through a slot in this bar passes a rod attached to the front end to the exhaust-valve push rod and loaded at the back end with a spring, which keeps the upright bar against a collar on the rod.

When the engine is stopped and the weighshaft moved over to carry the push rods clear of the cams, the exhaust-valve push rods exert an outward pull upon the trip-gear springs, causing the upright bars to move toward the front of the engine. This movement draws each bar under a roller pivoted on the flank of each exhaust-valve rocker, forcing the latter to open the exhaust valve to the extent of 2 mm., thereby relieving the compression for starting.

An ingenious automatic starting valve is employed. An airpot is fitted between each starting-valve stem and the overhead rocker which operates it. Normally, a spring in the airpot pulls the overhead rocker downward at the back end, so that the front end lifts the push rod and roller clear of the camshaft. During the running of the engine the starting-valve links are, therefore, motionless. So soon as the regulator handle opens up the air supply for starting, this air pressure acts upon the piston in the airpot, knocks up the overhead rocker, and brings the roller end of the push rod down upon the camshaft. With 300 lb. in the airpot, a rigid engagement between valve and rocker is maintained, and the starting air valves operate then in the ordinary manner. The air travels along a hollow spindle in the pot, and, therefore, directly the regulator handle is moved over to the fuel supply and cuts off the air, the starting valves are automatically relieved of pressure.

The engines for the "Selandia" were built by Burmeister & Wain, of Copenhagen.

CORRESPONDENCE

More Trouble Running at Full Compression

In a recent number of Power, I noticed a letter in answer to an inquiry as to why a gas engine would not run at full compression. I thought it might be interesting to the inquirer if I stated a case from my own experience. I was called to a gas engine in London one day because it was behaving in a similar manner to that described in Power. It would start up well and run at a moderate speed until full compression was put on; then it would suddenly miss fire for several cycles, pull up again, miss fire and gradually stop altogether. This puzzled me greatly for some time; I went over all the probable causes, valves, heat of tube (it was tube ignition), etc., and at last it occurred to me to start up again and investigate the suction at the gas bag. I immediately discovered the cause of the trouble.

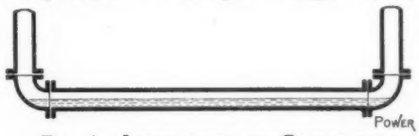


Fig. 1. Light-suction Condition

Fig. 2. Heavy-suction Condition

I found that a good healthy suction took place while running light, but as soon as the piston speed became at all rapid, a choking action occurred at the gas bag. Closer investigation showed that the gas valve had been leaky and too much lubricating oil had been used on the piston. In consequence, oil had got down the pipe between the gas valve and the bag. This pipe was in the form of a wide U so that at moderate suction the oil remained at the bottom of the pipe, as indicated in Fig. 1, but as the speed of the gas increased it pulled the oil along the pipe to the bend, where it choked the suction of gas (see Fig. 2) and the engine slowed down until the oil resumed its normal position again, when the engine picked up speed again only to slow down again and eventually stop.

When the pipe was cleared of oil the engine ran beautifully. Of course, the compression had nothing to do with the trouble, but the engine behaved as though it had.

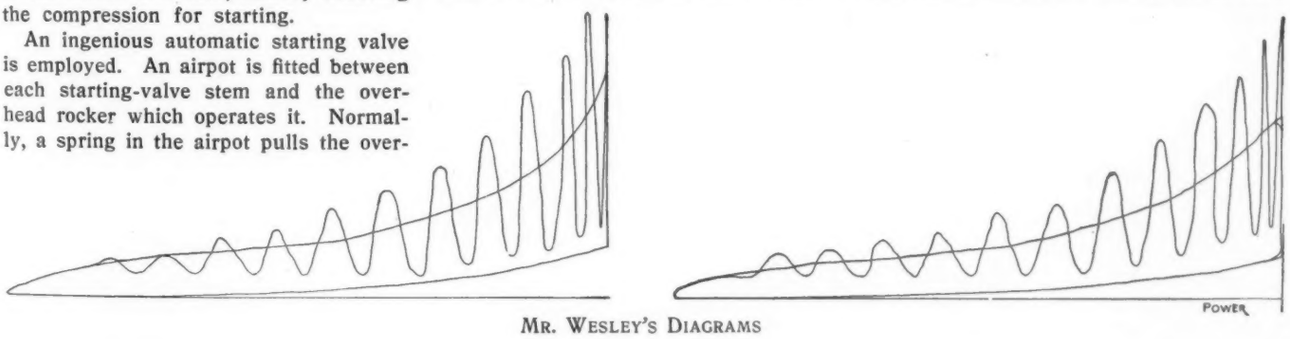
G. H. Humm.

Loughboro, England.

Freak Indicator Diagrams

Perhaps nothing is more interesting to the studious engineer than the consideration of freak indicator diagrams. Two such are reproduced herewith. The engine has a single cylinder 6¼ in. bore by 15 7/16 in. stroke and works on the usual four-stroke cycle. It is controlled by a hit-and-miss governor, scavenging on the idle strokes; the ignition is electrical, with make-and-break igniter; the spark was well advanced when the diagrams were taken, and a Crosby gas-engine indicator was used, equipped with a 280-scale spring. [The diagrams are reproduced here full size.—Ed.] Metallic surfaced cards were used, together with brass points, the pencil being held on during three complete cycles.

In each case two cycles were perfectly normal and were so nearly alike that the lines can be distinguished only by close inspection, though the tracing points were sharp and the diagrams distinct. Superimposed on each expansion line was the violently wavy line shown. This has been traced as a full line, but on the original card the tracing point failed to stay on the paper continuously, making a dotted line record. The engine was being tested under nearly full-load conditions at 260 r.p.m. with a prony brake and gave no evidence of undue stress. Can any of my fellow readers explain the oscillations of the pencil?



Mr. Wesley's Diagrams

G. M. Wesley.

LaFayette, Ind.

Refrigeration Department

Principles and operation of ice-making and refrigerating plant and machinery

Ammonia Absorption Refrigerating System

By Fred Ophuls

In the Aug. 23 issue of Power a short article appeared explaining the operation of a refrigerating system in general and of the ammonia absorption refrigerating system in particular. A more elaborate description of the latter system, showing the function of each apparatus, is given later. To assist in this work and show the relative positions of the apparatus the outline sketch is presented, together with tabulations to demonstrate the effect that different conditions of operation have upon its economy.

When designing and installing a refrigerating system to perform a given duty the conditions under which the plant will have to operate must be most carefully considered, particularly the temperature and the quantity of the condensing and cooling water available and the temperature at which the refrigerating duty must be performed.

The plant under consideration was used to cool calcium-chloride brine and in Table 1 are given the fundamental quantities upon which the various calculations made are based. Four different sets of operating conditions were assumed, the first two with 8 gal. of 72-deg. water and the last two with 4 and 3 gal., respectively, of 54-deg. water, per minute per ton of ice-melting capacity used for cooling and condensing.

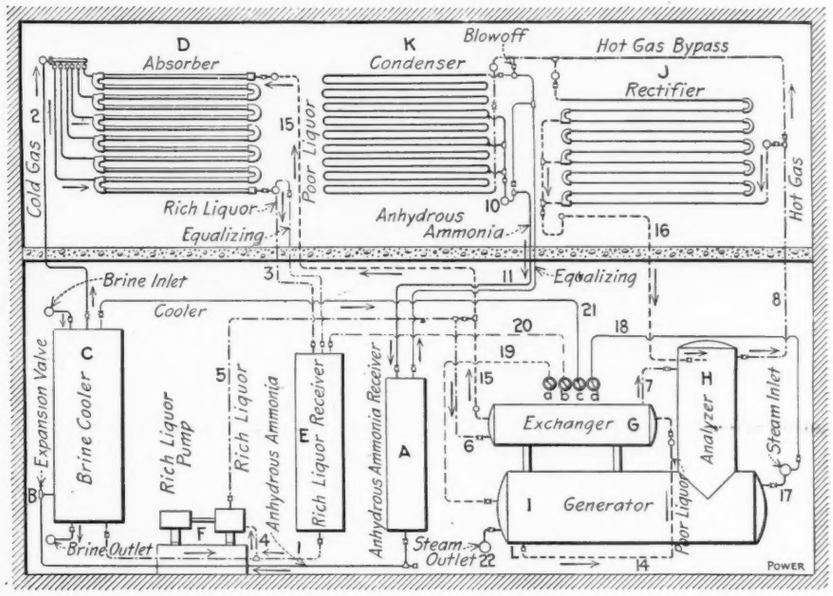
While the refrigerating duty is the same in each case, the temperature to be obtained in the refrigerator, that is, the average temperature of the brine, is assumed as — 12 deg. F. for the first three and + 8 deg. F. for the last set of figures. This change in the brine temperature is made to demonstrate its effect upon the economy of the system, the other conditions being nearly the same.

Ammonia, as the refrigerating agent, is used in the liquid anhydrous state in the refrigerator, where, by its evaporation at a low temperature while being maintained under a moderate pressure, it produces cold. The intensity of the cold produced depends upon the pressure under which the ammonia boils and the amount of cold upon the quantity of the liquid fed into and evaporated in the cooler.

Liquid ammonia can be purchased in the open market and the simplest refrigerating system would consist of a set of cooling coils, a brine cooler or other type of refrigerator to which the drum containing the ammonia would be connected and the liquid ammonia fed as required through a pressure-reducing or expansion valve, the other end of the refrigerator being open to the outer air or submerged in running water to allow the ammonia vapor to escape. Such a system would be dangerous, because ammonia fumes inhaled in large quantity are fatal, and it would be expensive as the liquid costs from 20 to 25c. per pound. Each pound can in evaporating absorb only about 450 B.t.u., or its cooling effect is equivalent to the melting of a little over 3 lb. of ice, the latter costing in large quantities about 0.15c. per pound or, for 3 lb., not quite one-half cent. Using the ammonia in this simple way would therefore cost from 40 to 50 times as much as ice.

As ice cannot be used for producing temperatures much lower than 40 deg. F., and for other good reasons, means have been devised to use ammonia for this purpose and, to avoid unnecessary expense and accidents, save the vapors formed and bring them continually back into the liquid form to be used over and over again. The only additional ammonia that must be supplied to a refrigerating system of this kind after it has once been completely charged is that which is lost through leaks and from other causes beyond the control of the operator. The ammonia is alternately in the liquid and the gaseous state and passes in a closed cycle through the various vessels of the system in the following rotation while the plant is in operation (see accompanying illustration):

A. Liquid ammonia receiver or storage tank.



Outline Sketch of Absorption Syetem

TABLE 1. FUNDAMENTAL QUANTITIES

	Number of calculation	1	2	3	4
1.	Cooling and Condensing water: Initial temperature	72	72	54	54
	Cooling and Condensing water: Quantity over condenser	4	4	4	3
	Cooling and Condensing water: Quantity over absorber	4	4		
2.	Refrigerating duty in tons of ice-melting capacity per 24 hr	125	125	125	125
3.	Temperature of brine: Initial	—8	—8	—8	+12
	Temperature of brine: Final	—16	—16	—16	+4

All temperatures are expressed in Fahrenheit degrees; weights in pounds; water quantities in gallons per minute per ton of ice-melting capacity per 24 hours.

A ton of ice-melting capacity or ton of refrigeration is equivalent to the absorption from the refrigerator of 200 B.t.u. per minute, 12,000 B.t.u. per hour or 288,000 B.t.u. per 24 hours.

Pressures are expressed in pounds per square inch gage.

Amounts of heat absorbed or rejected are specified in B.t.u. per minute unless otherwise specified.

B. Expansion or pressure-reducing valve.
C. Brine cooler or refrigerator.
D. Absorber.
E. Rich-liquor storage tank.
F. Rich-liquor pump.
G. Exchanger
H. Analyzer.
I. Generator.

TABLE 2. DERIVED QUANTITIES
Brine Cooler

	Number of calculation	1	2	3	4
4.	Pounds of liquid ammonia fed into cooler per min.	54.4	54.4	52.2	51.3
5.	Pressure in cooler	3.4	3.4	3.4	15.8
6.	Corresponding boiling point of anhydrous ammonia	—19	—19	—19	+1

J. Rectifier.
K. Ammonia condenser, finally returning to
A. Liquid ammonia receiver or storage tank.

The pipe line 1 connects the ammonia liquid receiver with the expansion or pressure-reducing valve *B* and the brine cooler *C*. Through this pipe the liquid flows, as regulated by the valve *B*, from the receiver *A*, where it is stored, to the brine cooler or refrigerator *C* and enters the latter under a pressure suitable for the temperature required in it. The weight of ammonia fed into the cooler is determined by its temperature just before it reaches the valve *B*, its latent heat at the cooler pressure and the quality and temperature of the vapor leaving it.

On this basis, the weight of liquid, in pounds per minute, circulated through the system for each of the four sets of calculations given in line 4 of Table 2 are figured. The refrigerator *C* may be of any construction suitable for the work to be performed.

The ammonia vapor, produced by the evaporation of the liquid in the cooler, is drawn away through the pipe 2 into the absorber *D*, where it is absorbed in a comparatively weak solution of ammonia in water, called weak or poor liquor, producing a rich liquor; that is, water practically saturated with ammonia at the pressure in and the temperature at which it leaves the absorber. The function of the absorber is to draw the ammonia vapor from the refrigerator and prepare it for the second stage of the process, which is to compress the vapor preparatory to reliquefying it.

In the compression system of refrigeration the ammonia vapor is drawn into the compressor and compressed by mechanical means to the desired pressure, while in the absorption system the affinity that water has for anhydrous ammonia is made use of for this purpose. Water in absorbing ammonia does not increase in volume materially, although it absorbs from 500 to 1000 times its volume of the vapor. The strong liquor retains the ammonia in a greatly compressed form.

In Table 3 the quantities pertaining to the operation of the absorber are given. Attention is called to the effect of the temperature of the poor liquor entering on the total heat rejected from the absorber. In the second set of figures the temperature of the poor liquor is nearly 80 deg. F. higher than in the other cases and this comparatively small increase has caused the amount of heat to be removed in the former case to be almost doubled.

TABLE 3
Absorber

7.	Pressure in absorber	1.9	1.9	1.9	14.3
8.	Temp. of poor liquor entering	107	181	99	105
9.	Ammonia vapor entering	0	0	0	12
10.	Temp. of rich liquor leaving	101	101	90	100
11.	Percentage by weight of ammonia in liquor — Poor liquor	18	18	22	27
12.	Percentage by weight of ammonia in liquor — Rich liquor	26	26	28	35
13.	Weight of rich liquor circulated per min.	558	558	678	468
14.	Weight of poor liquor per minute	503.6	503.6	625.8	416.7
15.	Heat of absorption of ammonia in poor liquor	47,328	47,328	44,631	42,579
16.	Negative heat of vapor entering	2,747	2,747	2,349	2,257
17.	Heat removed from poor liquor	3,022	40,288	5,632	2,084
18.	Total heat rejected from absorber	47,603	84,869	47,914	42,406

To obtain the best results from an absorber, it should be constructed so that, with the temperature and quantity of cooling water available for this apparatus, the final temperature of the liquid leaving it is as low as can be reasonably expected when allowing a proper construction expense for the apparatus.

The weight of ammonia that can be absorbed in water increases as the temperature of the water decreases; that is, the colder the water the more ammonia it will absorb, and increases also as the pressure at which the absorption takes place increases. It follows that the pressure in the absorber should not be maintained at a lower point than is absolutely necessary to obtain the desired temperature in the refrigerator. This fact is very often overlooked in the installation of this system, for it is claimed that the efficiency of the absorption machine is not materially affected by the absorber pressure. This statement is not in accordance with the actual facts, as will appear later.

It is also economy to keep the amount of liquor handled by the liquor pump as low as possible, not because the pump requires a great deal of steam for its operation, but because the heat lost in incomplete heat interchanges from the poor to the rich liquor is nearly in proportion to the weight of the liquor handled. A small quantity of liquor circulated per unit of work done requires a large difference in the strengths of the rich and the poor liquors. The strength of the rich liquor obtainable in any given size, type and construction of apparatus depends upon its final temperature when leaving the absorber and on the pressure; while the strength of the poor liquor is governed by the temperature of the steam in the generator coils and by the pressure existing in the ammonia part of the generator. The difference in the strengths of the liquors for modern plants ranges from 5 to 10 per cent. by weight. In these calculations 8 per cent. is the difference assumed except in the third case where, to keep the temperature in the generator coils as low as possible, the difference is only 6 per cent.

Knowing the strengths of the liquors and the weight of ammonia to be circulated per minute, the weights of the rich and the poor liquors can be computed and with these the total heat rejected from the absorber; these figures are given in line 18 of Table 3.

The rich liquor leaving the absorber flows by gravity through pipe 3 into the rich-liquor storage tank, where it is stored ready for use. The bottom of this tank is connected with the rich-liquor pump *F* by the pipe line 4. This pump takes the rich liquor and forces it through the pipe line 5 into the exchanger *G*, where it takes up heat on its way to the generator from the hot poor liquor flowing through the exchanger on its way from the generator to the absorber.

TABLE 4
Exchanger

19.	Temp. of poor liquor entering	265	265	224	207
20.	Temp. of poor liquor leaving	109	185	100	107
21.	Temp. of rich liquor entering	99	99	90	99
22.	Temp. of rich liquor leaving	237	175	205	180
23.	Heat removed from poor liquor	78,560	40,288	77,600	41,670
24.	Heat absorbed by rich liquor	74,600	38,000	73,800	39,600

The economy in steam consumption of any system using steam demands that where possible heat interchanges should be effected; that is, where any fluid must be heated and another cooled it is desirable to heat the fluid to be heated with the fluid to be cooled and *vice versa* and this heat interchange should be as complete as possible. In Table 4 the temperature and heat interchanges for the four problems are given. The only difference in the conditions of operation of cases 1 and 2 is the incomplete interchange of heat in the exchanger in the latter case, and this difference is assumed to show the importance of the foregoing statement. The effect of this fault in construction or operation will appear in the final results of the calculations.

To liberate the ammonia from the rich liquor it must be heated and to obtain the ammonia vapor at the proper pressure that will permit of liquefaction with the cooling water available, it must be heated when under that pressure. The liquor pump serves to discharge the liquor into the still or generator against the liquefying pressure.

Before following the course of the liquor from the exchanger into the generator it is well to consider what occurs when a rich ammonia liquor is heated. Taking, for instance, the figures pertaining to this part of the process for the first case, the rich liquor leaves the absorber at a temperature of 101 deg. F. and contains 26 per cent. by weight of anhydrous ammonia in solution. The liquor pump forces this liquor against a pressure of 138.3 lb. per square inch gage into the generator. On its way to the generator the liquor is heated in the exchanger and as soon as the saturation temperature at the pressure in the generator is reached, liberation of ammonia vapor from the solution will begin and end then only when the liquor has reached its final temperature in the generator. The latter temperature is dependent upon the strength to which it is desired to reduce the liquor.

In the first case, the poor liquor is assumed to contain 18 per cent. of ammonia, the ammonia condenser pressure is found to be 138.3 lb. per square inch gage and the final temperature of the poor liquor 270 deg. F. For these conditions the steam in the generator coils of a properly proportioned apparatus will not exceed 275 deg. F., which corresponds to a steam pressure of 30.8 lb. per square inch gage.

When ammonia is liberated from an ammonia liquor, or aqua ammonia, by the application of heat, a certain amount of water vapor is found in the vapor formed. On condensing this vapor a very rich ammonia liquor would be the result; that is, a liquor containing nearly 100 per cent. of ammonia. The disadvantages of using this liquor for refrigerating purposes are that its boiling point is not as low as that of anhydrous ammonia at the same pressure; further, that at the low pressure and temperature of the refrigerator the water in the liquor does not evaporate as freely as the ammonia, so that the final vapor does not contain the same percentage of water that the liquor did from which it is formed. The natural consequence of this condition is that the percentage of water in the liquor contained in the refrigerator constantly increases and the pressure in the latter must be reduced accordingly to maintain the proper temperature.

The efficiency of the system decreases as the percentage of water in the ammonia contained in the refrigerator increases, and it must be purged at frequent intervals. To minimize the effect of this condition, as much of the water vapor as possible must be removed from the vapor mixture before it is condensed and as the amount of water vapor contained in it will decrease as its temperature is decreased, it follows that to attain this end the mixture should be cooled to within a few degrees of the temperature of liquefaction before it reaches the condenser.

TABLE 5

Analyzer

25.	Temperature of vapor rising from generator	270	270	228	210
26.	Temperature of vapor leaving analyzer	242	180	210	185
27.	Temperature of rich liquor entering analyzer	237	175	205	180

TABLE 6

Generator

28.	Temperature of poor liquor leaving	270	270	228	210
29.	Temperature of steam in heating coils	275	275	233	215
30.	Pressure of steam in coils	30.8	30.8	7.3	1
31.	Pressure of vapor in generator	138.3	138.3	96.3	99.3

Here is another opportunity for taking advantage of heat interchange. The rich liquor leaving the exchanger is not as hot as the vapors rising from the liquor in the generator and an apparatus, the analyzer, is used in which the hot vapor mixture is brought into intimate contact with the rich liquor before the latter enters the generator. The mixture is thereby cooled, and some of the water it contains removed. Table 5 gives the temperature changes occurring in the analyzer, and in Table 6 are data pertaining to the operation of the generator.

The beneficial effect of cold cooling and condensing water and a high temperature in the refrigerator on the steam pressure required in the generator is clearly demonstrated by these figures. In the first and second sets of figures, the amount and temperatures of the cooling and condensing water and the refrigerator temperature respectively are the same; consequently the steam pressure is the same for equal capacity. In the third case, the temperature of the cooling and condensing water is lower and the quantity half of that used in the two previous cases, while the refrigerator temperature is the same and yet the steam pressure is only 7.3 lb. per square inch gage. In the fourth case, the water temperature is the same as in the third case, while the quantity is only three-quarters that used in the former case with a further decrease in the steam pressure to 1 lb. per square inch gage, because the temperature in the refrigerator is 20 deg. higher than for the other problems. These figures show conclusively that even in the absorption system the temperature in the refrigerator plays just as important a part in the economy of the system as in the compression type.

Referring to the illustration again, it will be understood from the foregoing why the rich liquor from the exchanger first enters the analyzer before it flows into the generator. The poor liquor leaves the generator at or near its bottom and flows through pipe 14 into the exchanger and from here as required through pipe 15 into the absorber. In pipe 14 a throttle valve is placed to maintain the required difference of pressure between the generator and the absorber.

This valve is so regulated that the liquid level in the generator is maintained at a predetermined height indicated in the liquid gage-glass provided for this purpose. This is necessary to keep the steam coils always submerged or to prevent the apparatus from becoming flooded with liquor. The steam coils are equipped with a steam trap at their outlet end that all the water of condensation may be drained off as soon as formed and not reduce the effective heating surface of the coils.

The vapor rising from the analyzer still contains considerable moisture and for the foregoing reasons it is further cooled in the rectifier before it is allowed to flow into the condenser.

In Table 7 data pertaining to the rectifier are given. There is a large amount of heat removed in this apparatus and considerable water vapor and ammonia are condensed and reabsorbed in it, especially for the first, third and fourth

cases, on account of the high temperature of the vapor leaving the analyzer. In the second case, the liquor enters the analyzer at a comparatively low temperature and for this reason the temperature of the vapor leaving it, and consequently its moisture contents, is low.

It is necessary to point out here that the proportion of water to ammonia calculated to be in the vapor liberated in the generator is probably somewhat larger than actually exists in a plant operated under the conditions assumed, but the information obtainable for the temperatures and pressures under consideration is so limited that it was necessary, to complete the calculations and description, to assume that the tension of the water vapor in the mixture is equal to the pressure of water—boiling at the temperature of the vapor mixture. This assumption probably leads to the finding of somewhat larger quantities of water vapor in the mixture than actually exist, but the difference between the assumed and actual amounts cannot be large and the discrepancy in the figures not serious, the more so as it is only desired to show plainly by their aid the functions performed by each of the apparatus of the system separately and also as a part of the whole system.

The function of the ammonia condensers and its effect upon the plant operation will now be considered; the results for the cases at hand are laid down in Table 8. The pressure in a condenser of a certain size and construction depends upon the temperature and the quantity of the cooling and condensing water showered over or circulated through it, modified to some extent by the presence of water vapor and of noncondensible gases in the system. The steam pressure in the generator and other important conditions are subject to the efficiency of this part of the plant.

The heat rejected from the ammonia condenser is determined by the weight of ammonia circulated, the temperature of the vapor entering and of the liquid leaving the condenser and in line 43 of Table 8 the total heat rejected in each case is given.

In the other tables the heat absorbed and rejected in the various vessels has been given with the exception of that absorbed in the generator. The heat interchanges in the analyzer are so complicated, and the heat furnished to the generator so much dependent upon the operation of this apparatus, that the only accurate way of finding the latter is by deduction from the thermal changes of the other apparatus.

The law of the conservation of energy states that energy can neither be created nor destroyed, and from this law it follows that, when any substance is made to do work in a closed cycle, like, for instance, that of a refrigerating system, in which the substance always returns again and again to the same state in the same part of the cycle, the total heat absorbed and the total heat rejected are equal.

In Table 9 the heat balance of the system is shown. The figures for the heat absorbed in the generator, in line 46, were obtained by summing up the heat rejected from the ammonia condenser, exchanger, absorber, poor-liquor line, rich-liquor line and rectifier and deducting from this sum the heat absorbed in the brine cooler and suction pipe, the remainder is the heat absorbed in the generator, neglecting the heat equivalent of the work done by the liquid pump, which is too small to be considered in approximate calculation.

Having found the heat that must be imparted to the rich liquor to drive off the ammonia, the weight of steam that must be fed to the steam coils in the generator can be figured. An allowance must be made in this item for the heat lost by radiation from the exposed surfaces of the generator and pipe connections around it. Table 10 shows in successive steps the calculations involved in finding the steam consumption of the machine. The final figures in line 60 tell the story. While they may be somewhat high in amount they are proportionately accurate.

To complete the circuit of the cycle it is found that the mixture of water and ammonia vapor rises from the analyzer and passes through the pipe line 8 into the rectifier *J*, the condensate returning to the analyzer through the pipe line 16 while the cooled and practically anhydrous ammonia vapor flows through pipe line 9 into the ammonia condenser *K*, where liquefaction takes place and the liquid formed returns by gravity to the liquid ammonia receiver *A* through pipe line 11 and is again ready to do refrigerating work, having completed the cycle circuit.

For convenience in operation, a set of four pressure gages is furnished so that the pressure existing in any part of the plant can be seen at a glance. The gage

TABLE 7

Rectifier

32.	Temperature of vapor entering	242	180	210	185
33.	Temperature of vapor leaving	82	82	65	65
34.	Temperature of liquor leaving	122	122	104	104
35.	Percentage of ammonia in liquor leaving	63	63	63	63
36.	Weight of ammonia vapor entering	83	59.4	68.7	59.1
37.	Weight of water vapor entering	16.5	2.9	9.7	4.55
38.	Weight of ammonia reabsorbed	28.6	5.0	16.5	7.8
39.	Total heat removed in rectifier	43,882	12,315	26,595	13,835

TABLE 8

Ammonia Condenser

40.	Condenser pressure	138.3	138.3	96.3	99.3
41.	Temperature of liquefaction	79	79	62	63
42.	Latent heat of ammonia at condenser pressure	505.3	505.3	516.8	516
43.	Total heat rejected from condenser	27,840	27,840	27,315	26,777

TABLE 9

Heat Balance. 1. *Heat Absorbed*

44.	In brine cooler	25,000	25,000	25,000	25,000
45.	In suction line	517	517	496	564
46.	In generator	105,199	109,226	85,969	63,480
47.	Total heat absorbed	130,716	134,743	111,465	89,044

2. *Heat Rejected*

48.	In ammonia condenser	27,840	27,840	27,315	26,777
49.	In exchanger	3,960	2,288	3,800	2,070
50.	In absorber	47,603	84,869	47,914	42,406
51.	In poor-liquor line	3,525	3,525	3,129	2,084
52.	In rich-liquor line	3,906	3,906	2,712	1,872
53.	In rectifier	43,882	12,315	26,595	13,835
54.	Total heat rejected	130,716	134,743	111,465	89,044

TABLE 10

Steam Consumption

55.	Heat absorbed in generator	105,199	109,226	85,969	63,480
56.	Radiation from generator	1,601	1,900	1,000	800
57.	Total heat supplied	106,800	111,126	86,969	64,280
58.	Latent heat of steam in generator coils	920	920	950	963
59.	Pounds of steam required per min.	116	121	91.5	66.7
60.	Pounds of steam used in generator coils per hour per ton of actual ice-melting capacity per 24 hours	55.6	58	43	32

marked *a* is connected through pipe 19 with the generator, the gage *b* through pipe 20 with the absorber, gage *c* through line 21 with the brine cooler and gage *d* with the steam coils of the generator. A pipe connection is also made between the rich-liquor pump and the bottom of the brine cooler so that the latter can be purged from time to time of the liquor which has accumulated. The top of the rich-liquor tank is connected with the top of the absorber so that the pressure in these apparatus can be maintained the same at all time to facilitate the flow of the liquor from the absorber into the tank. The top of the liquid ammonia storage tank is connected by a small pipe line with the top of the ammonia condenser for the same purpose.

It only remains to summarize the foregoing discussion and point out the salient facts step by step. The ammonia-liquid receiver or storage tank *A* is a receptacle in which the anhydrous ammonia is stored ready for use in the refrigerator. In a properly equipped plant the total volume of the receiver or receivers is 10 per cent. greater than the volume of the total charge of anhydrous ammonia in the plant.

The pressure-reducing or expansion valve *B* serves to maintain the proper pressure difference between the ammonia in the liquid receiver and that in the brine cooler or refrigerator and to regulate the amount of the liquid entering the latter for the refrigerating duty performed by the plant.

The brine cooler or refrigerator *C* is the vessel, apparatus or space in which the refrigeration takes place, and the construction of this part of the plant varies with the purpose for which the refrigeration is intended, the amount of the refrigeration and taste and skill in the art of the designer.

Economy in this part of the plant demands that the difference between the mean temperatures required in it and that of the evaporating ammonia shall be as small as practicable in view of the best engineering practice.

The absorber *D* performs the principal functions of the compressor in the ammonia-compression system of refrigeration; which are to remove the ammonia vapors from the refrigerator and compress them preparatory to their reliquefaction. The absorber should be so constructed that the liquor surfaces at which absorption takes place are ample for the work to be done and are located in close proximity to the heat-absorbing or cooling surfaces of the apparatus. Large liquor surfaces in the absorber allow of ready absorption of the ammonia vapors and their proximity to the heat-absorbing or cooling surfaces a low temperature of the absorbing surface of the liquor, resulting in a small difference of pressure between refrigerator and absorber and a rich liquor high in percentage of ammonia contents.

The rich-liquor storage tank *E* should be large enough to hold the complete liquor charge in the plant. The rich-liquor pump *F* draws the liquor from the tank *E* and discharges it against the high pressure of the system into the generator. The pumping of rich aqua ammonia is not as simple a matter as pumping a more stable fluid, on account of the formation of vapor in the pump cylinder caused by the reduction of pressure on the liquor entering by the suction action of the pump. Various patents have been taken out for constructions said to overcome this difficulty. The principal points to observe in the construction and installation of such a pump are small clearance, large valves and valve passages, equalizing pipe to the absorber and as much vertical drop as possible between the bottom of the liquor tank and the pump cylinder.

A gas-bound liquor pump causes trouble on account of its decreased volumetric efficiency, racing and hammering, similar to steam hammers in faulty steam-pipe construction.

The exchanger *G* is a very important part of the plant and serves to transmit the heat taken up by the poor liquor in the generator to the rich liquor entering it. In properly constructed apparatus, the temperature of the poor liquor leaving should not be more than 5 deg. higher than the temperature of the rich liquor entering. The proper difference of temperature between the poor liquor entering and the rich liquor leaving cannot be expressed in degrees of heat as the final temperature to which the rich liquor is raised depends on its strength. Under certain conditions of operation liberation of ammonia can take place in the exchanger, and in that case the total heat taken up by the rich liquor cannot be computed from its initial and final temperatures.

The analyzer *H* serves to partially dehydrate the vapor mixture rising from the liquor in the generator. At a casual glance, it would seem that to obtain maximum economy in steam consumption the rich liquor should enter the analyzer at or near the temperature at which it leaves the absorber, its lowest temperature in the cycle. This condition could be brought about by discarding the exchanger or by an incomplete interchange of heat in the exchanger. With cold, rich liquor entering the analyzer, the vapor mixture leaving it would have a comparatively low temperature and therefore contain but little water vapor, reducing the heat rejected in the rectifier.

The most complete heat interchange in the exchanger and consequent high temperature of the rich liquor entering the analyzer are conducive to best economy, as will appear from the final results of calculations Nos. 1 and 2. In the former the heat interchanged in the exchanger was nearly twice that in the latter, for otherwise the same conditions of operation. The liquor entering the analyzer was 237 deg. F. in the former and 175 deg. F. in the latter case, the heat rejected in the rectifier 43,882 and 12,315 B.t.u. per minute respectively, and, notwithstanding these facts, the steam consumption was only 55.6 lb. in the former against 58 lb. per ton of refrigeration in the latter case.

The ordinary analyzer is a vertical cylindrical tank either forming a dome on top of the generator or a separate vessel, in which a set of horizontal perforated trays are placed, one below the other. The liquor enters the top tray and overflows in thin films into the trays below, affording a large surface of contact with the vapor mixture flowing through it. The perforations in the trays are raised on the upper face so that a thin film of liquor coats the inside of the trays.

The generator *I* serves to liberate the ammonia vapor from the rich liquor. Economy in the operation of this apparatus demands that the difference between the temperature of the steam in the heating coils of this vessel and that of the poor liquor leaving it be as small as possible or consistent with the largest heating pipe surface and its best distribution that can be used in the generator. A difference of only 5 deg. F. in these temperatures requires a large heating surface per unit of capacity of the apparatus and an effective distribution of this surface.

In the rectifier *J* the dehydration of the vapor mixture is nearly completed. The proper operation demands a construction that will permit the reduction in temperature of the vapor passing through it to within a few degrees of the liquefying temperature in the ammonia condenser, a small quantity of cooling water and a comparatively high final temperature f the liquor condensed in this apparatus and returned to the analyzer.

The ammonia condenser *K* should be so constructed that with the temperature and quantity of cooling and condensing water available the minimum practicable pressure of liquefaction is obtained. It is an apparatus used in all types of refrigerating systems.

The final conclusions of the quantitative analyses of the absorption system are the following:

That, contrary to generally accepted views, the steam consumption of the absorption refrigerating increases rapidly with a decrease in the temperature of the refrigerating medium in the refrigerator.

That the quantity of cooling water necessary for efficient operation is double that required for a compression system with a single steam engine and the same as that for a compression system with a compound condensing engine.

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POWER

The Value of Dry Steam

There is steam and steam.

Steam may be just plain steam with exactly enough heat in it to keep it as steam under the existing pressure. In this case it is said to be "dry saturated." If it lost any of its heat, a portion of it would condense.

It may be more than dry. It may be heated just as air or any other gas may be to any temperature above that of dry saturation. In this case it is said to be "superheated."

Or it may, and usually does, carry with it a considerable quantity of unevaporated water. In this case it is said to be "wet" or "moist." Of course, the term "steam" is strictly applicable only to the portion which has been evaporated and is still in the vaporous condition, but the whole mass is commonly referred to as "steam" and its quality indicated by the proportion of the whole, by weight, which persists in the form of vapor.

Steam having a quality of ninety-eight per cent. is a mixture of ninety-eight parts by weight of steam and two parts of unevaporated water. All sorts of clumsy terms, such as "mixture," "steam stuff," etc., are used to designate this material. The water in it has been simply raised to the boiling point but not evaporated, and as it takes at one hundred and fifty pounds pressure, considerably over two and a half times as much heat to evaporate the water as it does to raise it to the boiling point, even from thirty-two degrees the wet mixture has much less heat and potency than the dry steam.

But the moisture in the steam is not only a negative quantity, it is a positive detriment. Its presence aggravates the heat interchange between the working medium and the cylinder walls which is the greatest source of loss in the reciprocating engine and militates against the efficiency and longevity of the turbine by dragging upon its swiftly revolving surfaces and eroding the blades upon which it is projected with an enormous velocity. The first few degrees of superheat, the change from somewhat wet to positively dry steam, has an effect upon turbine efficiency out of all proportion to the difference in heat contents or "available" energy.

There is another advantage to dry steam which is not so often discussed; it does not carry over foreign material from the boiler with it as wet steam does. A case of severe cylinder cutting was traced to the boring out of the boiler tubes and the carrying over by the steam of the fine sharp powder which had not been thoroughly cleaned out. When a superheater is used it will soon become scaled up if some five per cent. of the water is evaporated upon its surfaces.

It behooves one, therefore, when buying a boiler or considering boiler and engine performances to take into account the kind of steam in question. A boiler may get rid of twelve pounds of water for each pound of coal burned, but is the "stuff" which it delivers all steam? And it is not enough, for practical considerations, that this evaporation should be reduced to the equivalent evaporation in dry steam, for the boiler which delivers its steam practically dry is a good deal more than five per cent. better for the man who is going to drive an engine with it than a boiler which delivers a mixture of ninety-five per cent. of steam and five per cent. of moisture.

Two Kinds of Avoidable Explosions

If one planned deliberately to get up an explosion, he could hardly do better than to put kerosene into a vessel like a boiler or heater open for cleaning, especially if it were somewhat warm as a boiler or heater is likely to be, and then to stick a torch into the manhole. It would seem as though any man of ordinary commonsense—and much more an engineer—could foresee the consequences of this combination. But accidents from this cause are of frequent occurrence.

We are advised of a recent one in the plant of the Western Fuel Co., in British Columbia, where one of the engineers, after having washed out the boiler, put some coal oil into it and then started to enter it with an open light to examine the feed-pipe outlet. The explosion was violent enough to tear off the sheet-metal siding of the boiler house, and the man was severely burned.

Another class of accident which we are called upon to record less frequently but still occasionally, is the bursting of a piston which is being heated up in a forge fire. The heating of the air which the piston contained would result in a pressure of less than one hundred pounds, but the presence of a little moisture in the interior of the piston would increase this pressure enormously, while if there were any oil present the conditions for an explosion in the compressed and highly heated air of the interior would be ideal when the temperature reached that of ignition.

Compensation of Consulting Engineers

The compensation of the consulting engineer was touched upon by Charles T. Main in a recent address before the Association of Engineering Societies, of which he is president. The remarks coming from a well known member of the profession deserve special attention since they also reflect the opinion of a considerable number in that field.

The principal contention of Mr. Main was that the compensation of a consulting engineer should not be figured on a time basis, but rather upon the importance of the services rendered. If the advice given effects a saving in the cost of production or causes the client to embark upon an enterprise which will net a large profit, then the fees of the engineer should be commensurate. In support of this contention it is pointed out that the advice is often a concentrated form of knowledge which it has taken years of experience to acquire; during which period the practical experience was considered a part of the remuneration.

Of course, Mr. Main makes it plain that this cannot be applied to the regular pursuit of design and construction where a definite fixed sum or percentage must be charged, the aggregate of which cannot be large unless the undertaking is unusually big.

We agree with Mr. Main that the compensation for engineering services should be in accord with the results attained; it is the same line of argument which we have so often expounded, to the effect that if a fireman, by intelligent handling of the fires, saves ten per cent. of the fuel, he is entitled to share in the pecuniary saving. However, there is this difference in the two cases: the engineer's fee would be influenced to a large extent by his reputation and would probably be fixed in advance, whereas the fireman's compensation would be based upon the actual saving effected; that is, after the amount of this saving had been definitely made known.

Mr. Main ascribes the relatively low prevailing rates of compensation to the natural modesty of the consulting engineer which bars a full appreciation of the worth of the professional services rendered. We are inclined to believe it is more of an economic problem than one of modesty. However, with the elevation of the profession and a recognition of its importance, there should come an opportunity for better financial returns, although millionaire engineers will probably remain a scarcity for many years to come.

Using the Firm's Stationery

The fact that the average young urchin usually has a dirty face does not necessarily infer that he belongs to a slovenly kept household, although he may convey that impression; but the begrimed boy's mother oftentimes believes that his condition is a reflection upon her management of the home.

It is true that a man's shortcomings will react against the interests of those with whom he is closely associated, and this axiom has found ample illustration in the discussions that have been published in this journal on using the firm's stationery.

Some engineers who used the firm's stationery when writing to certain manufacturers of power-plant apparatus did not receive a reply. Was it because the appearance of the letter gave the impression that the firm which the engineer represented was insignificant? Perhaps the letter was ungrammatically constructed, or the words misspelled; it may have been smeared with ink-blots and smudged with grease. It is more than likely that such a letter would tend to produce the impression that the concern whose name appeared on the letterhead figured small in the business world, and that its engineer was equally diminutive.

As a comparison, suppose the letter had been neatly typewritten, grammatically expressed and properly spelled; it would then have given the recipient a better impression of the writer and of the firm which he represented.

While most manufacturing concerns may not waste time on a proposition which does not look good, even to the sending of a catalog, it is not always good business practice to acknowledge only perfection letters. Many an engineer with purchasing power neglects to write carefully and is not always able to spell correctly, but he orders the goods; therefore this question should be considered from all sides.

The engineer should strive to make his business letters reflect the standing of the company with which he is identified, and the manufacturer should not take the standpoint that giving attention to a poorly written letter must necessarily mean a loss of time; it may mean a sale and a permanent customer.

An engineer told us the other day that he has just resigned a good position "because the old boilers were unsafe." Here is a man who rose to the occasion and came down with both feet. Perhaps if he had stayed any longer, he would have "risen" all right—in company with the old boilers.

Many people in all walks of life seem to be exceeding fearful that they will miss the psychological moment. The engineer who knows his work will tell you that every operating moment is one of those hard-sounding elements of time; there is no choice between them.

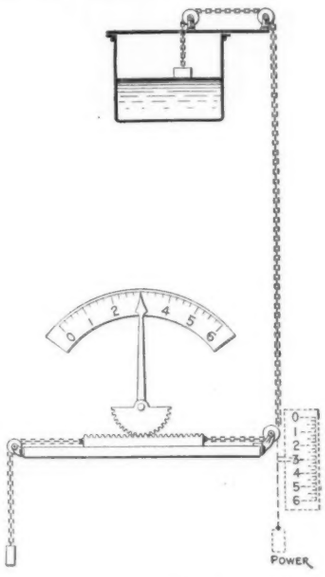
When the plant owner is made to realize that in the black smoke issuing from his stack his money is being wasted in unburned products of combustion, he will not wait for legislation to abate the nuisance.

Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Water Tank Gage

A tank water gage is made by attaching a gearwheel to the indicator arm, the gearwheel engaging with the rack which slides on the base, as shown. One end of the rack is connected by a chain to the float in the tank; the other is connected to a weight.



TANK GAGE

When the tank is empty, the indicator hand will be at zero. As the tank fills with water the float rises and the weight draws the rack toward the left. This movement rotates the hand over the dial, and indicates the depth of water in the tank.

An indicator can be arranged as shown by the dotted lines with the indicator attached to the float chain.

EDWARD L. JOHNSON.

Brooklyn, N. Y.

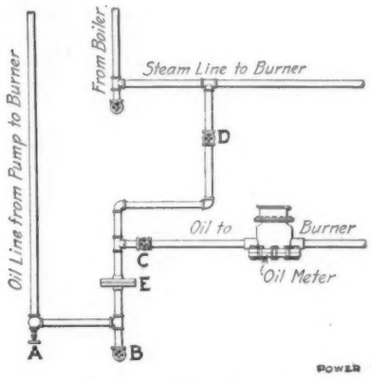
Strainer for Fuel Oil System

The accompanying sketch is of a strainer and water trap on the oil line of my oil-burning system, in which *E* is a flange union one size larger than the pipe. A 24-mesh wire screen is inserted between two pieces of woven asbestos packing.

To clean, close the valves *A* and *C* and open the valves *B* and *D* slowly and blow the sand and grit that accumulate on the under side of the flange coupling out through the valve *B*. Then close the valves *D* and *B* and open valves *A* and *C* and the oil line is clear.

Put a long nipple between the valve *B* and the tee so as to trap the water that comes in with the oil. The valve *D* must be absolutely tight.

I use an over-flow valve on the discharge pipe from the oil pump and leave it partly open and do not have to stop the pump to clean the strainer. I took steam for the oil burner and pump from the top of the boiler dome and tapped the branch pipe to the oil burner from the top of the steam pipe in order to get the dry steam.



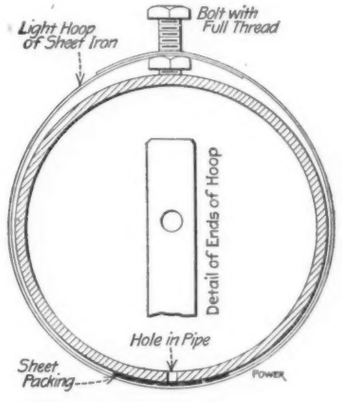
STRAINER FOR FUEL OIL

C. D. COOK.

Turon, Kan.

Temporary Pipe Repair

It frequently happens that a pipe springs a leak and it is impossible to cut it out of service immediately to put in a new section. In such a case the temporary repair kink illustrated herewith may be used to good advantage.



METHOD OF MAKING TEMPORARY REPAIR

Cut a piece of light sheet iron wide enough to cover the leak fully and long enough to fit loosely around the pipe and lap over as shown in the accompanying figure.

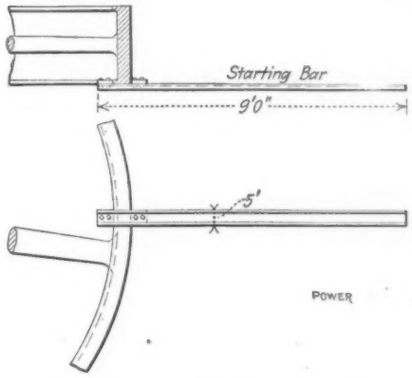
Place a bolt with a full thread against the pipe opposite the leak, as shown, and after slipping a piece of sheet packing under the iron band at the leak, tighten up on the nut. Gently tap the iron band while tightening the nut so as to make it draw up evenly.

LEO C. STAAL.

Pittsburg, Penn.

Channel Iron Starting Bar

The starting bar shown in the illustration saves much time in our engine room. Before its use a 16-ft. belt wheel had to be turned over by means of a tackle; this method was very cumbersome.



CHANNEL-IRON STARTING BAR

The 9-ft. bar is made of 5-in. standard channel iron and weighs about 60 lb. It cost $2.

RULOF KLEIN.

New York City.

Firemen's Bonus System

A bonus system of paying the firemen prevails in a large chemical works, this system being based on these four items: constancy of steam pressure, percentage of coke in ash, stack temperatures and CO_2 in the flue gas.

Records of this information are kept by means of pyrometers, CO_2 recorders, recording gages and by frequent analyses, and at the end of the month the shift making the best showing is paid a bonus which amounts to about $5 per man per month. As there are three eight-hour shifts, this induces a lively competition among the shifts, from which both the men and the company benefit.

As a direct and further result of acquiring this information about their conditions, the company has made a number

of changes in the arrangement of the boiler settings, such as covering the outside of the settings with a course of hollow tile lined with a layer of asbestos, changing the area of the grates, etc., and the showing made by this practice is a saving of about 14 per cent. in the total fuel burned.

M. W. CAMPAU,
Manager Precision Instrument Co.
Detroit, Mich.

Removing Keys

The accompanying sketches show three ways of pulling keys from a Corliss valve stem.

In Fig. 1 is shown a clamp which is made to fit into two grooves chipped in the key. A bolt is passed through the clamp to keep it from spreading. The horizontal top piece is supported by two blocks, and the nut on the vertical bolt is then screwed down and the key is thus pulled upward by the clamp.

In Fig. 2 a hole is drilled in the end of the key and is then tapped for a cap screw. Tightening the cap screw will withdraw the key.

In Fig. 3 is shown a drift made of a piece of ¾-in. octagonal tool steel. A groove must be filed in the key, as shown. A ¼-in. rat-tail file is best for this purpose. If a little kerosene oil is poured around the key, it will find its way down to the binding parts and will sometimes help to loosen the key.

SAMUEL H. FARNSWORTH.
Chicago, Ill.

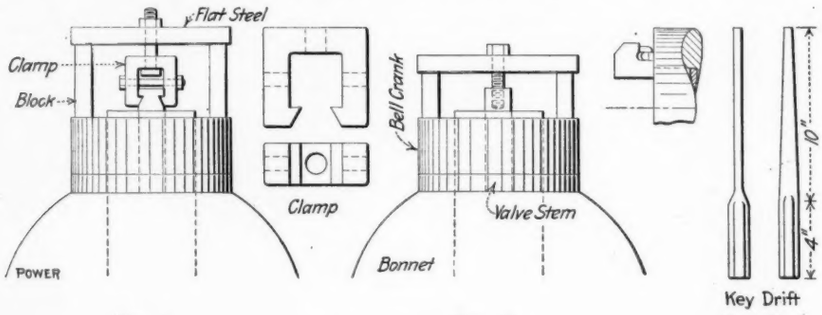


FIG. 1 FIG. 2 FIG. 3
THREE WAYS OF REMOVING KEYS

Canada's License Law

I have followed the discussions on license laws with much interest. Many correspondents seem to think there is graft connected with it in certain states. An assertion of that nature regarding Canada's license law would be laughed at by the engineers themselves. We have the highest standard for stationary steam engineers' licenses on the continent and, furthermore, they are enforced without fear or favor.

Engineers should not overlook the advantages gained by the enforcement of license laws. It compels engineers to learn more of their profession, to start studying and, when started, continue. Many engineers here are receiving higher wages than they were when the law went into effect in 1900, and men now holding low-grade licenses have experienced no reduction in wages over that received before the enactment of the law.

BERT SWANTON.
Vancouver, B. C.

Engine Wreck

Recently the cylinder of a 16x22-in. four-valve engine was completely wrecked, caused by the breaking of the main rod in the outer strap bolt-hole.

This engine at the time of the accident was making 165 r.p.m. with a working pressure of 125 lb. It was loaded to its full capacity, and working perfectly quietly. The rod parted with no warning; the cylinder was broken, the piston split, the piston-rod buckled, and the valves were broken. An examination showed an old fracture, the bright metal of the break being only ⅜ in. thick, and it evidently ran that way for some time. The fracture could not be seen as it was on the back side of the rod and on the dark side of the engine.

The engineer was within 4 ft. of the engine but he could not close the throttle, as it was also on the back side, and the cylinder could not be passed without loss of life. The boiler valves were closed and the water level noted in each boiler. The engineer escaped injury.

BURT M. SEYMOUR.
Delphos, Ohio.

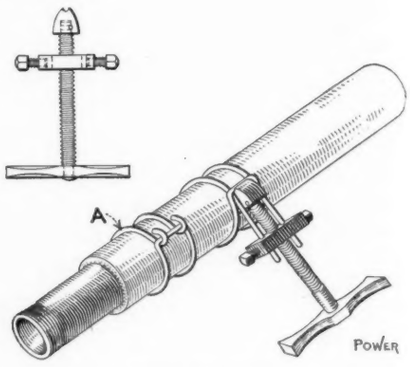
Engineers' Daily Reminder

This idea can be worked out by using a calendar, composed of separate day sheets, and a set of rubber stamps to mark the work to be performed at stated times in the future. Miscellaneous memoranda can be put down under the date it is desired to attend to any particular piece of apparatus. The idea works well, helps make one systematic and can be carried out to any extent.

FRANK MARTIN.
College Point, N. Y.

Home Made Hose Coupler

The hose coupler shown in the accompanying illustration can be easily and cheaply made by most any engineer. It will be found a very useful adjunct to the plant.



HOSE COUPLER

The illustration shows the instrument and its application. The wire clamp is attached to the hose at *A*. No. 8 wire for 1-in. pipe, and No. 6 for 1- to 1½-in. pipe make very suitable clamps.

J. G. KOPPEL.
Montreal, Can.

On to His Job

Good repair men about a steam plant are hard to get and are not appreciated or compensated one-half enough.

Our repair man got an engineer's license and a young man came to take the job. He had a high-school diploma, one from an engineers' correspondence school, and enough recommendations to cover a yard of paper; he also had one of those perpetual-motion smiles.

The fellows dubbed him professor, and he was well named, for he could talk power house, he knew what he was talking about and work was his middle name.

One night at shutting-down time, when he should have been ready to go home, I saw him standing around with a wrench in his hand and asked him what he was going to do. He said he was going to fix the induction-fan engine up a bit as he was tired of hearing it pound. After shutting down I went with him to see what he did. I suspected the pound was in the crosshead. The professor thought so too and took out the wristpin, turned it true and babbitted the boxes. When he started up the pound was still there. Then he leveled the rod and put in a new set of metallic packing; when he started up the pound was gone.

He fooled with the economizer until it raised the feed-water temperature about 15 deg.

One of the generator pits kept filling with oil and had to be bailed out by hand. He made an ejector out of some pipe and connected it to an air line and forced the oil into a barrel.

A motor-drven plunger pump that took care of the drains of the heating system failed; he removed the cap to the suction chamber and put in a new set of suction valves and springs. Then the pump worked worse than before. I thought he was stuck, but he measured the distance from the pump to the receiver, took out the springs, cut off one coil, put them back—and the pump worked all right. He said the trouble was caused by the pump not having a vacuum on account of the hot water and that the head was not great enough to overcome the stiffness of the springs.

He had a third-class license; and why he did not have a first I could not see. He was a shark for knowledge. As soon as POWER came he would grab it and disappear. After he had read it through he would bring it back and talk about the different articles to the profit of all.

A. W. GRISWOLD.

Adams, Mass.

Pump Would Not Force Water

The accompanying sketch shows how a centrifugal pump was recently installed. The pump and motor are located on the river bank, 1800 ft. from the mill.

The electrical energy is supplied by the mill generator and is transmitted to the motor through a No. 000 copper wire on the positive side; the discharge pipe from the pump is used as the negative line, proper connections being made at the motor and the switchboard.

The pump is set 25 ft. below the earth surface in a boxed well and is driven by a 10-kw. motor by means of a vertical shaft turning 1500 r.p.m. The suction pipe is 3 in. in diameter, and the discharge pipe is 2 in. The maximum lift is 8 ft. and the pump discharges against a 65-ft. head.

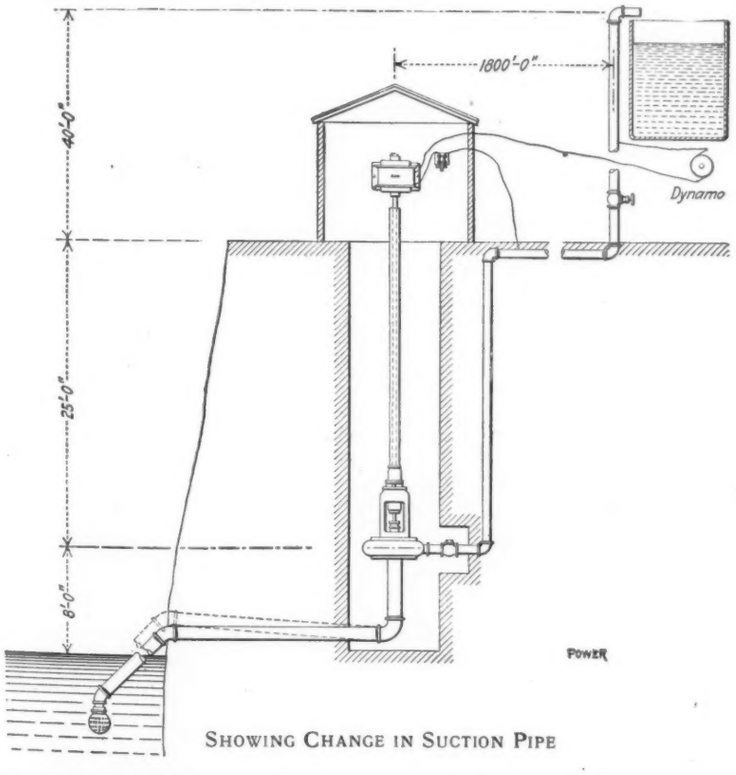
The pump in question will not lift water when the suction pipe is in a horizontal position, although $100 was expended for labor in 10 days in trying to make it do so by priming, etc.

At last the engineer suggested raising the suction pipe about 4 in., as shown by the dotted lines. This was done and the pump has been putting water in the tank at the rate of 6000 gal. per hour ever since.

Why did raising the suction pipe remedy the trouble? I would like to hear from some of the readers of POWER who have had practical experience with centrifugal pumps regarding this case.

J. W. DICKSON.

Memphis, Tenn.



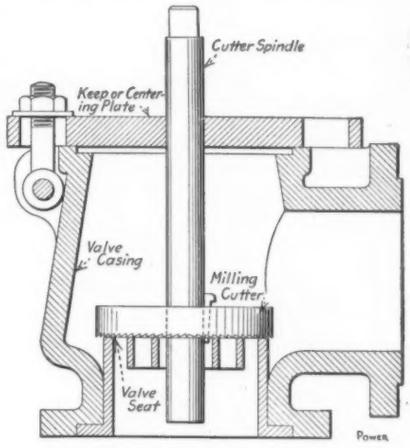
SHOWING CHANGE IN SUCTION PIPE

Valve Seat Grinding Tool

I was recently employed as chief engineer of a 2500-hp. plant having six water-tube boilers. I soon noticed that one of the boiler-feed pumps ran much too fast for the amount of water being evaporated.

One day I instructed my repair man to shut down the pump for examination and found the valves in good condition, but the composition valve seats were scored badly. The pump was of the pot-valve, duplex, outside-packed type, 10 and 7 by 10 in., taking water from an open heater at a temperature of about 190 deg. F. and pumping against 140 lb. boiler pressure.

After writing to the builders for prices on new seats I figured it would be an expensive job, so I took measurements and made a tool to reface the seats in place, which did away with the trouble. The accompanying sketch will give an idea of the tool and cutter.



VALVE SEAT GRINDER

A wheel was used for turning the spindle and cutter by hand. The guide piece across the top was drilled to fit the spindle closely and was held in place by the stud nuts. The tool cost about $8 and faced the valve seats good as new.

MILTON T. MONTEITH.

North Cambridge, Mass.

Peculiar Corrosion

On taking charge of a plant in a large mill, I found the boiler tubes leaking badly. Instead of leaking at the heads, which is usual in such cases, the water was issuing from the tubes along the sides. My suspicion of bad feed water had been aroused, as water left for some time in a tin can would turn the tin black.

Examination showed the tops of the tubes to be badly corroded, and in many places holes were eaten through the tubes; those eaten partly through showed the metal to be bright when the incrustation was removed. It was peculiar that the shell was only slightly affected while the tubes were seriously so.

A sample of the water, which came from a well and was very clear, was sent to a chemist for analysis. While awaiting a remedy new tubes were put in and finely powdered graphite put into the boiler. This seemed to prevent the corrosive action as the old tubes soon stopped leaking.

Will some reader explain why the tubes only were attacked seriously while the shell, except slightly along the water line, was unaffected?

JAMES W. LITTLE.

Fruitland, Wash.

Questions Before the House

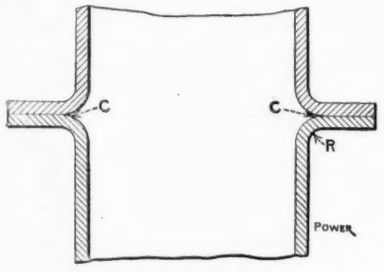
Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Reinforcing Van Stone Joints

In the issue of Feb. 27, Mr. Stevens compares the strain on the pipe and bolts in an 8-in. standard pipe with van stone joints.

To find the strain on the bolts due to the pressure it is necessary to use the area of a circle whose diameter is from *C* to *C* in the accompanying figures. With 1 in. radius at *R*, the circle is nearly 10 in. in diameter, and its area is 50 per cent. greater than the area of the pipe, and with 4000 lb. pressure per square inch it will give trouble. It is almost impossible to calculate these strains, and hence the details of pipe joints are much better determined by experience.

If experience shows that the bolts fail when the pipe is in line and expansion



SECTION OF PIPE AT JOINT

is taken care of, and the pipe does not vibrate excessively, it would be time to put in stronger bolts, but not because the factor of safety is only 10 in the bolts and 20 in the pipe. Personally I have not been troubled much by breaking bolts when these conditions were fulfilled.

The strains caused by lack of alignment are greater in the pipe than in the bolts as these bolts are farther from the center. The total strain in any pipe cannot be greater than enough to break the bolts, and strains due to expansion, vibration and lack of alignment are better taken care of in other ways than by making the system like the famous one-horse shay, when it fails all over if at all.

The standard weight of pipe was determined a long time ago and was made strong enough to have threads cut and still be strong. If a pipe is in line and expansion is provided for, it does not vibrate excessively. Why is not a factor of safety just as good in a pipe as in a boiler? It might not be good to use lighter pipe, but why use a factor of safety of more than 10 for the bolts and only 6 for the boiler?

HARRY D. EVERETT.

Fort Apache, Ariz.

Finding the Boiler Horsepower

In the issue of Mar. 19, mention is omitted of a most useful application of the supplemental chart. By means of this chart, it is possible to find accurately the boiler horsepower of a boiler making steam of any quality without reference to any other tables, and with but little calculation.

For instance, take a boiler evaporating 1000 lb. of water at 60 deg. F. per hour to steam, 95 per cent. dry, at 100 lb. gage, and let it be required to find the boiler horsepower. From the chart is readily obtained the factor of evaporation of 1.151. By multiplying this factor by 1000 the equivalent evaporation is had from and at 212 deg. F., which is equal to 1051 lb. per hour. This divided by 34.5 (the value of a boiler horsepower in pounds of water evaporated per hour from and at 212 deg. F.) gives directly 33.36 boiler horsepower, or

$$\frac{1.151 \times 1000}{34.5} = 33.36$$

The rule is as follows: To find the boiler horsepower multiply the factor of evaporation as found from the chart by the pounds of water evaporated per hour, and divide by 34.5.

LOUIS GROSSBAUM.

New York City.

Supplementary Exhaust Valves

In his criticism of my article in the Apr. 2 issue, Wendelin Sange states under the above title, that the engine would run poorly "if it would run at all," as "the pistons are far too short to cover the exhaust ports while the steam acts on the main piston."

I would call his attention to the fact that the size of the piston valve would entirely depend on the size of the port, the overthrow of the eccentric, and also, its angular advance. Since he did not specify the above in the case of his engine, he did not show that the length of the piston in my drawing is inadequate.

At any rate, my intention in the original letter was solely to show the means by which the reduction of the back pressure was accomplished; and my drawing was sufficiently clear to convey the intended information.

As to the data given by me on the age, speed, etc., of the engine, and reduction of back pressure, it was based on information received from Mr. Sange.

VICTOR BONN.

New York City.

Comment on Pressure Problems

In answer to Mr. Hawkins' first question, in the Mar. 26 issue, I say that when the gage has no pressure upon it the tube will be filled with air at the pressure of the atmosphere and when the pressure is turned on if the gage is connected to a siphon which will condense the steam, the water will advance into the tube as far as the air after being compressed will allow it. To illustrate: If the tube was 5 in. long and 100 lb. pressure would compress the air contained in this size tube into a space 1 in. long, then the tube would be filled with water for 4 in. of its length and with air for the remaining inch. This proportion would vary with the pressure, for since there is no means for the air to escape it must fill part of the space in the tube.

If the gage was connected at the top of a vertical pipe filled with steam—which is the wrong way, since the heat would soon injure the tube—the air might take up slightly more space on account of its increased expansion; but there would not be much difference. This principle is illustrated in traps, radiators and any pipe having no way of circulating the steam.

For the second question, consider whether a gage placed at the end of 3000 ft. of ½-in. pipe would indicate the same pressure as one located on the boiler. It must be borne in mind that after the pipe is once filled with water there will be no flow except as the pressure increases, which will be so slow as to cause almost no perceptible friction, and as the area of the ½-in. pipe is at least four times that of the opening in the gage, there will be but little change in the pressure in that length of pipe; neither would it indicate a sudden change of pressure as quickly as the one at the boiler as the long body of water would move slowly. If there is nothing else connected to the pipe

but the gage there should be no perceptible drop in pressure.

As for the third question, it is found that the pressure available at this steam pressure would be about 277 lb. per square inch. Deducting the amount required to overcome the 10-ft. static head, there would be 277 lb. — 4.34 lb. = 272.66 lb. available.

Assuming a piston speed of 100 ft. per minute, the pump should deliver 293.8 gal. per minute, and deducting the 20 per cent. slippage, 235 gal. is being delivered into the pipe. According to the tables on friction loss in pounds per square inch, the loss for a flow of 250 gal. per minute through a 4-in. pipe is 1.89 lb. for every 100 ft. in length. If the pressure 272.66 lb. is divided by the loss per 100 lb. or 1.89, it will give 144.24, and this result multiplied by 100 will give 14,424 ft. of pipe necessary to overcome the pressure at the pump, but as the friction of liquids in pipes increases as the square of their velocity, there would be but a small amount of water delivered by the pump available at the end of the pipe, although theoretically, since the pressure is all taken up in friction, there should be no water flowing.

As water is incompressible there would have to be friction enough in this body of water to prevent the plungers moving at all, for if they did move the water would have to go somewhere, so that it would either burst the pipe near the pump or flow out at the further end.

G. H. KIMBALL.

East Dedham, Mass.

I say that the spring of a steam gage may contain either steam, water or air, but it should contain water. A well known steam-gage company states that "every gage used to indicate the pressure of steam should have a siphon or other device which will furnish water to and completely fill the tube springs to keep them cool."

A gage may be placed at any distance from a boiler and yet register correctly provided no steam is taken from the connecting pipe and there is no chance for water pockets to cause hydrostatic pressure. The 3000 ft. of ½-in. pipe, horizontal and closed, would give correct gage readings.

As the length of the horizontal discharge pipe is increased the pipe friction is increased up to the point where the static head plus the friction head balances the plunger slip. Again, the friction head is dependent on the condition that there shall be a flow of water, since if there is none there is no friction. Hence it would seem that the pipe cannot be made long enough to stall the pump, so there will always be a discharge from the pipe.

J. K. MCINTYRE.

Newburgh, N. Y.

The contents of the spring tubes in a steam gage depend entirely upon existing conditions; steam at ordinary temperatures may be allowed to enter and fill the spring while for high temperatures oil is often put in the siphon of the connecting pipe to prevent deterioration of the metal tubes. If the oil completely fills the spring, there is no air, of course, but undoubtedly there is usually some air caught above the oil. The spring may have air, or oil, or both, or steam inside it.

Both gages will show the same pressure, 100 lb., irrespective of the distance apart or the size of the pipe; static pressure is constant for a given level in any one system.

The third question seems absurd; if there is to be no discharge of the water there is no velocity; hence no friction. Also a pipe of infinite length would be necessary.

HUBERT L. WATSON.

West Lafayette, Ind.

[Many of our correspondents construed the third question submitted by Mr. Hawkins to mean a vertical instead of a horizontal pipe. Various vertical lengths have been given, ranging from 507 to 11,000 ft.

Fred. L. Wagner contends that the pressure in the discharge pipe which will balance the pressure in the steam cylinders is 277.77 lb.; that a pipe high enough to balance this pressure will be 277.77 lb. × 2.3 = 638.871 ft.

Arthur Scrivenor claims that if there were no slippage, the vertical pipe would be about 640 ft. high: that as the pump is of the outside-packed plunger type the slippage must be through the valves, but this slippage is not constant; hence the height of the column of water in the pipe would vary.—EDITORS.]

Mr. Clark's Diagrams

These diagrams, in the Mar. 19 issue, plainly indicate a broken bellcrank or stem on one of the steam valves; and probably a broken stem inside the stuffing-box or valve chamber, since any outside break would have been evident at once, and the taking of a diagram to find the trouble would have been unnecessary.

The right-hand diagram from the end with the broken stem shows that the valve stands wide open throughout the stroke. The loop to about one-half initial pressure at the end of the stroke is due to the opening of the exhaust valve, allowing the steam to blow through to the atmosphere. When the exhaust closes, the pressure rises to a little above initial pressure, due probably to the inertia of the steam in the supply pipe, which results in the loop at the top of the diagram.

The diagram for the other end shows the normal valve adjustment, but it is somewhat distorted, due to the steam blowing through the other end. This would account for the inclined steam line and the high back pressure.

The bottom line is the atmospheric line and should not be connected to the "toe" of the diagram as shown.

If Mr. Clark's engine exhausts to the atmosphere, and he had listened to it for a moment, he would have discovered what was wrong. I recently had a similar experience on a 26x48-in. engine which occurred in the early morning hours and created quite a disturbance.

F. P. READ.

Memphis, Tenn.

Connecting Rod Ends

Referring to Mr. Pullen's letter in the Mar. 5 issue, it is rare that the wear is equal enough to allow the same adjustment on both pins after one or two adjustments.

This is true because it is impossible to foretell how much each pin and its brasses are going to wear. As this type of rod requires the same amount of adjustment on each pin it is plain what the results will be.

The rod does, of course, work seemingly satisfactorily upon gas engines as there is little or no pressure upon the caps.

LLOYD V. BEETS.

Nashville, Tenn.

What the Diagrams Show

J. F. Reynolds, in the Mar. 26 issue, shows that the steam distribution in both cylinders is very good; the receiver pressure at first sight appears low when contrasted with the boiler pressure, but when it is considered that the low-pressure cylinder is, in round numbers, six times the volume of the cylinder, the reason for the apparently low receiver pressure becomes plain. I believe it is too high, for upon figuring the power developed in each cylinder, and using the mean effective pressure as given on each diagram, respectively, I find that the low-pressure performs more than twice the amount of work the high-pressure is doing. The powers are, 17.5+ for the high-pressure and 36 for the low-pressure. Of course, there may be a reason for the large difference in the powers; but unless there is a good reason for this difference, it seems to me that Mr. Reynolds can reduce his receiver pressure by an amount to cause a more nearly equal distribution of the work.

Cutoff occurs at about ⅛ stroke, which is too early for the best economy; and this seems to show that the engine is too large for the work it has to do, at the prevailing steam pressure; perhaps it would do better with a lesser boiler pressure.

CHARLES J. MASON.

Scranton, Penn.

While I think Mr. Reynolds' diagrams are very good and the compression is sufficient for such slow speed, the low-pressure cylinder is doing more than double the work of the high-pressure cylinder. If conditions will permit, the load ought to be more uniformly divided between the two cylinders.

WALLACE JOHNSON.

Utica, N. Y.

The indicator diagrams show a very good setting of the valves, the cutoffs being nearly equal for the two ends of the cylinders, and the mean effective pressures being about as nearly equal as it is practicable to get them. The distribution of work between the two cylinders, however, is a long way from equal, as the following computations will show.

Neglecting the areas of the piston rods, the diameters of which are not given, the results above are obtained.

Area of high-pressure piston	113 sq.in.
Area of low-pressure piston	707 sq.in.
Stroke of engine	2.5 ft.
I.hp., high-pressure head end (113×2.5×34.25×30) ÷ 33,000	8.8
I.hp., high-pressure crank end (113×2.5×34×30) ÷ 33,000	8.7
Total i.hp. for high-pressure cylinder	17.5
I.hp., low-pressure head end (707×2.5×11.2×30) ÷ 33,000	18.0
I.hp., low-pressure crank end (707×2.5×11.3×30) ÷ 33,000	18.1
Total i.hp. for low-pressure cylinder	36.1

There are two reasons why the power developed in the low-pressure cylinder is more than double that in the high pressure. First, the unusually large cylinder volume ratio, 6.25: 1, makes it difficult to get an equal distribution of the load when running at the light load indicated by the very early cutoff in the high-pressure cylinder. A decrease in volume of the low-pressure cylinder, the high-pressure remaining the same, would mean, for the same total indicated horsepower, a later cutoff in the high cylinder, and a more equal distribution of the work.

Second, the load can be partially equalized, by a decrease in the receiver pressure. This means, of course, a lower back pressure in the high-pressure cylinder, and therefore an increase in the mean effective pressure, and the mean effective pressure of the low cylinder will be correspondingly decreased.

A. L. WESTCOTT.

Columbia, Mo.

Injectors Will Not Work Properly

J. L. Brouse, in the Mar. 5 issue, asks whether both injectors erected as shown by his drawing would work at the same time in a satisfactory manner. I say they will not, because the two currents will butt each other and one or both injectors will break. Why not use only one injector of ample capacity, thus relieving the operator by one-half? If this cannot be done, connect them to a Y-fitting and there will be no trouble.

I also note that both injectors are operated from one outlet in the boiler; hence the boiler outlet should not be less than 2 in. if the steam inlet to the injectors are 1¼ in. in order to avoid the injectors breaking because of insufficient steam supply when both are in operation. If 45-deg. ells cannot be had, bend several pieces of pipe in order to get the injectors to stand horizontally.

WILLIAM S. LUCKENBACH.

Oakview, Penn.

Preventing Clogged Blowoff Pipes

Commenting on Mr. Amstutz's letter in the Mar. 12 issue, on "Cleaning a Clogged Blowoff Pipe," I suggest that he blow off his boiler every six hours; if the water is exceedingly impure, every four hours would not be too often. In this manner he can save himself much hard labor and never be troubled with a clogged blowoff pipe.

C. E. ALDRICH.

Mendota, Calif.

What Broke the Crosshead?

Referring to H. R. Williams' crosshead accident mentioned in Mar. 26 issue, I believe that something got in between the end of the cylinder and the crosshead shoe, so that when it came in on the return stroke it struck the obstruction, breaking the crosshead. As the engineer had just packed the rod, preparatory to starting up for the night run, no doubt he was in a hurry, and unintentionally left a packing tool lying across the guide. In starting up the engine its vibration as it came up to speed jarred the tool until it fell into the hollow of the guide lengthwise. The crosshead hit the tool in this position, bending the adjusting bolt upward, and breaking the lower part of the crosshead. The buckling strain would then force the shoe and broken part out on the floor. Similar accidents have been known to happen.

L. M. JOHNSON.

Glenfield, Penn.

It is evident that there has been undue strain on the bottom shoe, and some extra friction must have caused the guides to heat; possibly the crosshead was too tight or the shoe came loose and the end cut into the guide.

I believe that it was too tight in the guides and when heated expanded the crosshead, and together with the working force (which force is on the lower guide when the engine is running over, and on the upper guide when running under) deflected the shoe, breaking it at the weakest point on the head end. As the extension on the main part of the crosshead was weak it broke also.

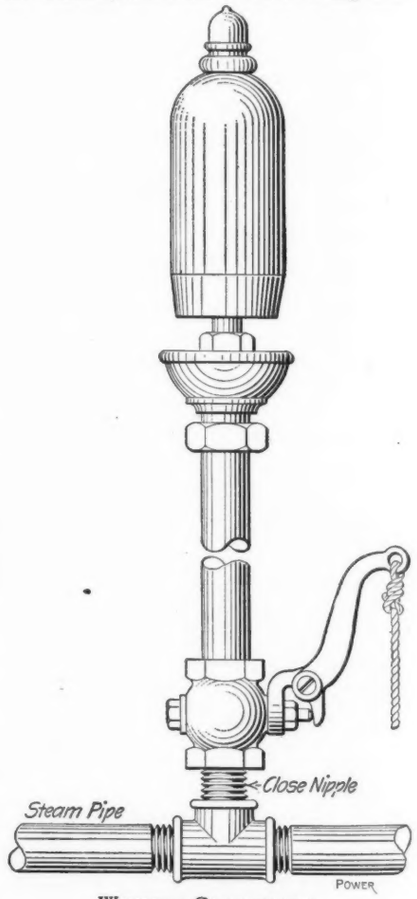
If the crosshead in the sketch is correct as to proportion, it looks to me as if the head end, where the break occurred, is of small cross-section when considering the cantilever load.

R. G. COX.

Milwaukee, Wis.

Whistle Connection

In reply to Harold Beecher's letter in the Feb. 2 issue, on drain for an exposed steam whistle, I wish to say that my whistle valve is located in the boiler room and the whistle is on the roof. No drain is attached to the steam pipe of the whistle, the whistle valve being connected with a close nipple to a steam pipe in which there always is dry steam, as, for instance, the pipe for the boiler-feed pump. The arrangement is shown in the illustration.



WHISTLE CONNECTION

My whistle valve has a renewable disk, and whenever the valve starts to leak, the disk is renewed at the first opportunity. The valve and whistle have been connected as shown for 11 years and freezing has never occurred during cold weather.

H. A. JAHNKE.

Milwaukee, Wis.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Power Required to Pull a Load up an Incline

What power would be required to pull a load of 100,000 lb. up a one-mile incline in 10 minutes if the vertical height is 100 ft., and the resistance due to friction is 5 per cent. of the power required?

E. S.

The work required to raise the load to an altitude of 100 ft. would be

$$100{,}000 \times 100 = 10{,}000{,}000 \ ft.\text{-}lb.$$

A horsepower is equivalent to 33,000 ft.-lb. Therefore the horsepower required would be

$$\frac{10{,}000{,}000}{33{,}000} = 303 \ hp.$$

if the work were done in 1 min. But as 10 min. are required it will take one-tenth of this, or 30.3 hp. As the power required to overcome the friction is 5 per cent. of the total load, 30.3 hp. is 95 per cent. of it. The total load is

$$\frac{30.3}{0.95} = 31.895 \ hp.$$

Reverse Current Steam Separators

What is the principle of a reverse-current steam separator?

J. G. B.

The direction of the flow is abruptly changed, usually through 180 deg. This causes the water in the steam, on account of its greater specific gravity, to be thrown into a receiving vessel, while the steam passes on in the reverse direction.

Auxiliary Heaters

How many square feet of heating surface per pound of water is considered good practice in an auxiliary heater?

H. P.

An auxiliary heater connected to the exhaust line of a condensing engine should have about 1 sq.ft. of heating surface of brass or copper tubes for every 60 lb. of water passing through the heater per hour.

Injector as a Boiler Feeder

Which is the most efficient, an injector or a steam pump, as a boiler feeder?

J. O'B.

With an injector the amount of heat taken from the boiler is returned to the boiler, less a slight loss due to radiation. From a heat-efficiency standpoint, it is nearly perfect. As a means of forcing water into the boiler it requires more steam than the most wasteful of pumps.

Speed Variation of a Corliss Engine

Does the speed of a Corliss engine change under full load?

J. McK.

A Corliss engine runs slower with full load. If it did not the governor balls would not run in the lower plane necessary for the later cutoff.

High Steam Pressures

What are the advantages and disadvantages of high steam pressures?

B. J. W.

High-pressure steam is advantageous because of the greater range of temperatures that can be utilized for power and their saving by reduced cutoff. Their disadvantages are: increased danger of rupture at the weak joints in the boilers and pipes, increased loss by radiation, decomposition of lubricants, increase of leakage, and larger cost of power plant to meet the increased pressure.

Brake Horsepower

What is the rule for obtaining the brake horsepower of a motor with a prony brake?

A. H. K.

Multiply the length of the lever from the center of the shaft to the center of the point of application to the scale, by the number of revolutions per minute, by the difference between the weight in pounds indicated on the scale when the brake wheel is in motion, and the weight indicated, when the wheel is at rest, and by 6.2832. Divide the result by 33,000, and the quotient will be the brake horsepower of the motor. Example: The speed of a motor is 960 r.p.m., the length of the brake arm from center to center is 12 ft. The weight of the arm indicated on the scale is 21 lb. and the weight indicated when the motor is running is 72 lb. Substituting figures, the rule would be expressed as follows:

$$\frac{6.2832 \times 12 \times 960 \times (72-21)}{33{,}000} = 111.8 \ b.hp.$$

Total Heat of Saturated Steam

In a recent issue of POWER, the total heat of steam above 32 deg. F. at 105 lb. absolute was given as 1187.2 B.t.u. Is this correct? The table which I use gives it as 1182.9 B.t.u.

S. J. C.

The value 1187.2 B.t.u. for the total heat of steam of 105 lb. absolute is from the Marks-Davis tables. Prof. Peabody's revised tables give it as 1186.9, the difference being due to the inclusion in the Marks-Davis tables of the heat equivalent of the feed-pump work and to Prof. Peabody's use of 778 ft.-lb. as the mechanical equivalent of heat, while Marks-Davis use 777.52 B.t.u. Prof. Peabody uses the heat required to raise a pound of water between 62 and 63 deg. for his thermal units, while Marks-Davis use the average heat required to raise a pound of water 1 deg. between 32 and 21.2. The values given by the older tables are too low. See paper by Dr. Davis, A. S. M. E., Proc. Vol. 30, 1908.

Per Cent of Moisture in Steam

What would be the percentage of dry steam and moisture if, when using a separator calorimeter, the weight of dry steam was 13 lb. and the weight of water obtained was 9.2 oz.?

C. B. M.

Divide the weight of dry steam by the sum of the weight of the steam and the water, and multiply by 100. Both quantities must, of course, be expressed in the same units. 9.2 oz. = 0.575 lb. Then for your case

$$\frac{13}{13 + 0.575} = 0.958$$

or 95.8 per cent.

Load Factor of Engine

What would be the load factor if an engine rated at 125 hp. was developing 126.25 hp.?

C. J. B.

The engine would be developing

$$\frac{126.25}{125} = 101 \ per\ cent.$$

of its rated capacity. This is sometimes referred to as the load factor, but the term is more frequently used, especially as applied to a station, to express the ratio of the average to the maximum load.

Brownhoist Suspended Bin

The Brownhoist patent suspended bin, an installation of which is shown in Fig. 1, is designed for storing coal, ashes, coke, sand and other materials in bulk, and its construction is such that the material forming its sides and bottom utilizes its tensile strength to resist the strains set up by the load.

This bin consists essentially of two plate girders supported by columns or side walls, usually by columns, as shown in Fig. 2. The girders are inclined from the vertical so as to make the straps and the outside of the bin tangent to the

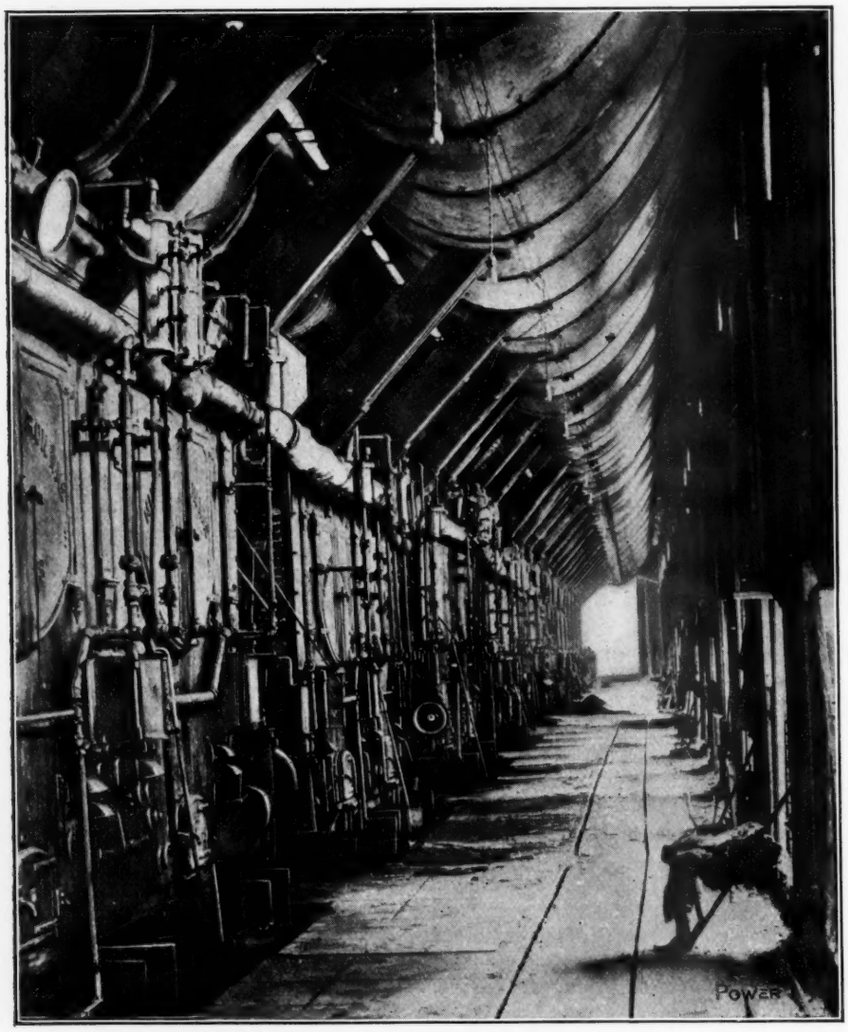


FIG. 1. AN INSTALLATION OF BROWNHOIST SUSPENDED COAL BINS

girder. At intervals of from 3 to 5 ft., depending on the load to be supported, steel straps, which are parabolic in shape, are hung from these girders. The straps are made strong enough to carry the weight of the reinforced-concrete lining and the material to be stored in the bin, and are shipped straight and formed to shape in erection and then riveted to the lower side of the beams. The entire weight to be supported is concentrated in these straps by reason of the reinforced-concrete lining acting as a beam between the straps.

In lining a bin with a "ferroinclave" reinforced-concrete construction, a wooden strip about ⅜x1 in. wide is first placed on the inside of the curved straps and made to conform to the contour of the straps. The "ferroinclave" sheets are then placed on these strips and are secured to the straps with small bolts. The sheets are shingled at each lap, which makes practically a continuous member the whole length of the bin, and by reason of being able to shingle the sheets at the laps only one line of bolts is required to each strap.

When the "ferroinclave" is in place the upper side is coated with a mixture of one part of portland cement to two parts of sand, or with a mixture of one part portland cement, two parts sand and four parts broken stone, all stone to pass a ½-in. mesh. The thickness of this lining varies with the span and loading, allowance being made for wear, which is generally about 1 or 1½ in. The thickness of the concrete on the inside of the bin generally varies from 3 to 4½ in. at the bottom and gradually tapers to about 1 or 1½ in. at the top of the bin. When the inside cement has set it appears as shown in Fig. 3. The under side of the "ferroinclave," shown in Fig. 4, is then coated with a mixture of one part of portland cement and two parts of sand with the addition of a small amount of goat hair. The mixture is pushed in between the straps and the "ferroinclave" so as to solidly fill the ⅜-in. space made by the wooden strips, which practically gives a ⅜-in. coating on the outside of the "ferroinclave."

In lining the inside of the bin enough open reinforcement is included to cover the girder and any other exposed places that would come in contact with the stored material. This reinforcement is secured to the girder by a special clip. In this way the girder is completely protected from the corrosive action of the material in the bin. Generally, steel plate linings are protected from corrosion by a coating of portland-cement mortar 1 to 2 in. thick and secured to the plate by wire netting and clips.

The ends of the bins are usually made by fastening angle clips onto the last strap and connecting I-beams or channels to these clips to act as struts that run horizontally across the end to give the necessary required strength to resist the component forces from the load in the bin. A ⅜x⅜-in. wooden strip is then laid along the inside of these struts and the "ferroinclave" sheets laid on these wooden strips and fastened to the struts. The sheets are then concreted on the inside to a thickness of between 3 and 4½ in. at the bottom, depending on the load in the bin, and tapered to about 1 or 1½ in. at the top, similar to the concreting of the siding of the bin. After the concrete has set, the outside is then concreted similar to that described for the side of the bin.

These bins are made in capacities ranging from 1 to 15 tons per lineal foot. The bin can be used in almost any plant, for, on account of its peculiar shape, it can be designed to the capacity requirements and still be placed in the boiler room without occupying valuable space in front of the boilers.

This bin requires practically no repairs as the concrete lining is noncorrosive and fireproof. The exposed parts, such as the gates, chutes and spouts, can be easily removed without destroying the concrete lining in any may. The bin is self-emptying, and in many cases a concrete housing is carried up to the roof, thereby making an almost dustproof boiler room.

Practically any form of chute can be used in connection with the bin, but a special chute is made, the main advantage of which is that it can be locked open or shut by virtue of its toggle mechanism. The gates of the chute are op-

erated from the floor by a hand chain, and the coal is delivered centrally on both gates, which open simultaneously. This is shown in Fig. 5. The spades and chute casting are constructed so as to thrust large pieces of material either in or out without jamming.

The chutes are connected to spouts of which there are several designs. One of the designs is to be used in connection with a line of stokers on one side of the bin only and has at the bottom of the spout a spreader or distributor placed to get the proper distribution of coal on the bunker. A straight spout without any spreader at the bottom is also made, but is pivoted to the chute at the top so that it can be moved across the face of the stoker while the coal is being fed.

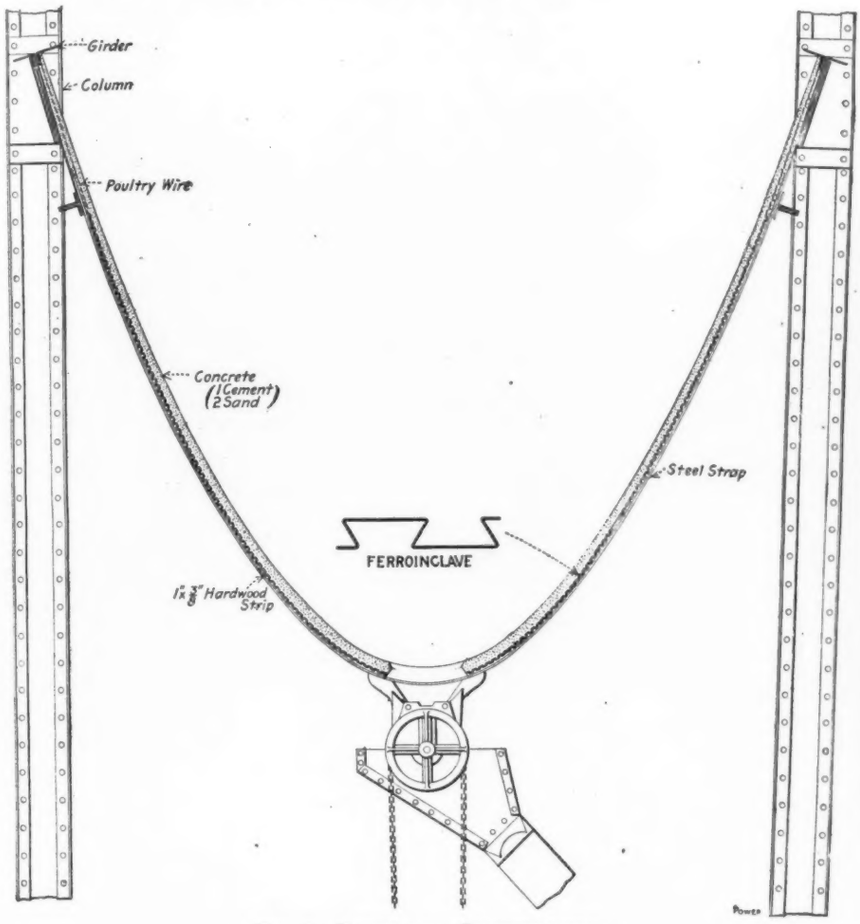


FIG. 2. DETAILS OF CONSTRUCTION

For installations where the boilers and stokers are on both sides of the bin a straight spout is used without a spreader at the bottom and so designed that it can be swung from one stoker to the other that is directly opposite it; thus a single spout and chute can be utilized to supply the coal to two stokers, thereby eliminating the expense of the extra mechanism. To feed the stokers in this design the spout must be moved across the face of the stoker while the coal is flowing. Another style of spout is frequently used, although it is somewhat more expensive than the one just described, inasmuch as each stoker has its separate chute and spout. To accomplish this the location of the chutes are staggered so that they come between the stokers instead of opposite them, which is the usual way, and the spouts are then designed on an angle so as to bring the orifice in the center of the stokers. These spouts have a spreader at the end to give an equal distribution of coal.

In connection with these chutes a line of stationary and movable hoppers are manufactured in which the coal can be accurately weighed and, if necessary, recorded before being fed to the stoker.

This bin and attachment are manufactured by the Brown Hoisting Machinery Co., Cleveland, Ohio.

FIG. 5. GATES TO BIN

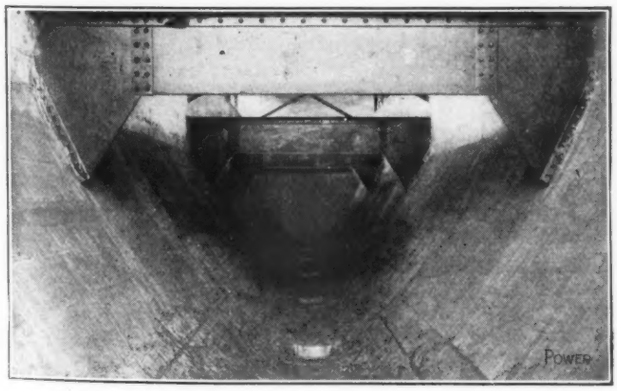


FIG. 3. CEMENTED INTERIOR OF BIN

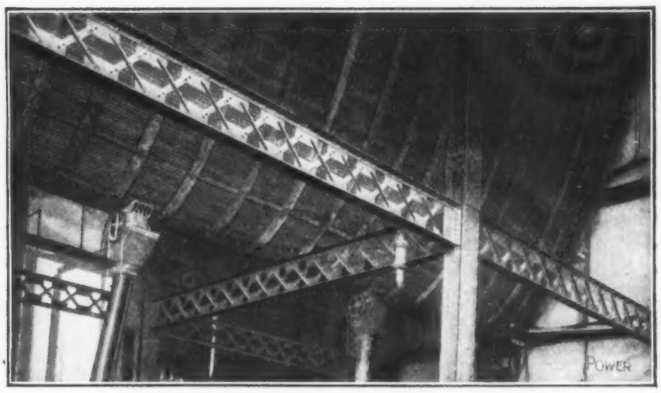


FIG. 4. EXTERIOR OF BIN BEFORE APPLYING CONCRETE

San Antonio Locomotive Boiler Explosion

The accompanying illustrations show the condition of the outside sheet of the firebox of the locomotive boiler which exploded at San Antonio, Tex., Mar. 18, an account of which was published in the Apr. 9 issue.

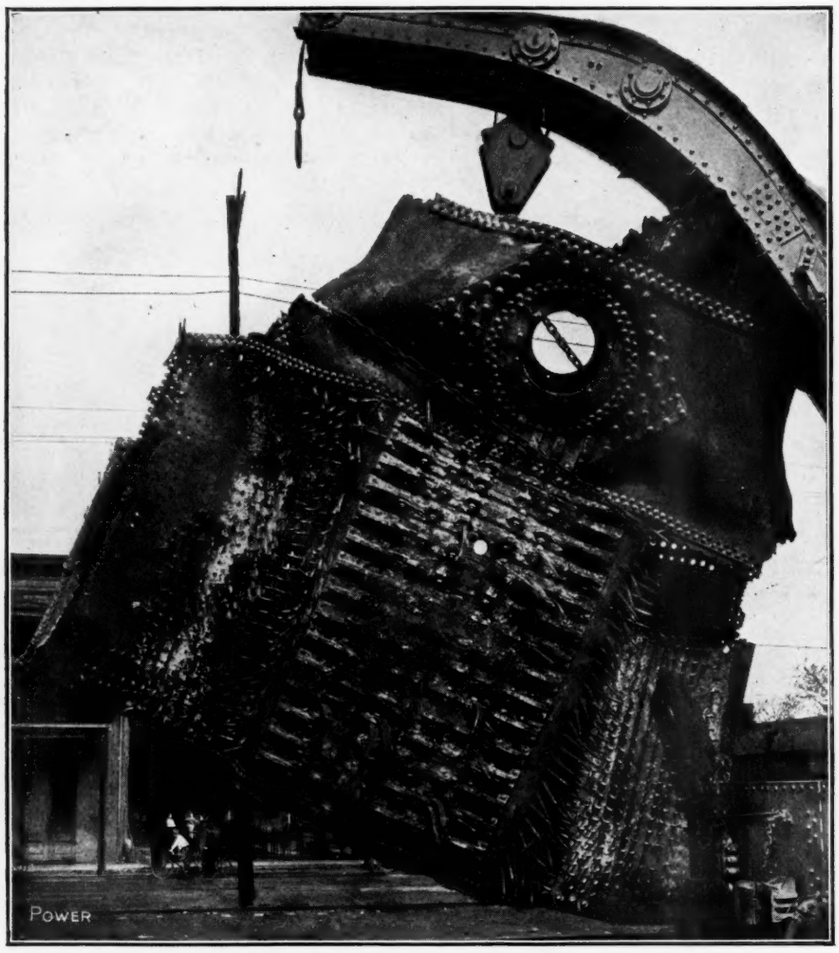


FIG. 1. OUTSIDE SHEETS OF THE FIREBOX SHOWING STAY-BOLTS AND BROKEN SLING STAYS

The 6-ton sheet, shown in Fig. 1, was hurled through the air nearly a quarter of a mile. It is an interesting study, as it shows the condition of the stay-bolts and broken sling stays. It will be noticed that the former pulled out of the fire sheets, remaining in the outside sheets, or were broken off, leaving portions of the stay-bolts in both sheets. The photograph indicates that less than 60 stay-bolts pulled out of the outer firebox sheets.

The bird-shaped plates, illustrated in Fig. 2, are the same as shown in Fig. 1, but in a different position.

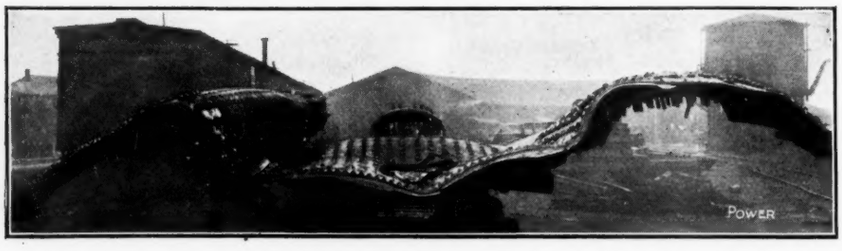


FIG. 2. OUTER FIREBOX SHEETS SO BENT AS TO RESEMBLE A HUGE BIBD IN FLIGHT

Boiler Explosion Wrecks Factory

By the explosion of a boiler in the S. A. Wellman handle factory, at South Boardman, Mich., on Apr. 5, the engineer was killed and five other employees were injured.

The accident took place at the noon hour; the engineer was eating dinner in the fire pit in front of the boiler when without warning the boiler burst, hurling him against the side of the building, then covering him with hot bricks and burning timber. Both legs and one arm were broken, his back wrenched and he was badly scalded. He died shortly afterward.

Portions of the boiler were found several hundred yards away. The scattered ashes and sparks set fire to the ruins, and two of the men would have been cremated if they had not been promptly rescued. The cause of the explosion is unknown.

Boiler Explodes at Orilla, Wash.

A 100-hp. boiler in the Orilla Lumber Co. plant exploded at Orilla, Wash., on the morning of Apr. 10. Though the boiler and engine room were wrecked, the blacksmith's shop near-by was crushed by a heavy piece of boiler plate, and six persons were standing in the immediate vicinity, no one was fatally injured.

The dynamo and engine were also wrecked and the roof was lifted off the mill. No cause is known for the explosion, the press reports offering the usual surmise that the water was low in the boiler.

Receivership for Allis-Chalmers Co.

On Apr. 6 receivers were appointed for the Allis-Chalmers Co., in the persons of D. W. Call, president of the company, and Gen. Otto H. Falk, president of the Merchants and Manufacturers' Association, of Milwaukee.

While no statement could be obtained from the company, the receivership has in all probability been declared as a means to facilitate the early reorganization of the company, details of which have been given in recent issues.

The receivership will fully protect all parties dealing with the Allis-Chalmers Co., and guarantees the prompt fulfillment of all outstanding and future contracts, and there will be no cessation of activity in any line.

A Convenient Chart

The De Laval Steam Turbine Co., of Trenton, N. J., has recently got out a convenient form of the Mollier diagram accompanied by a measuring scale by which the desired quantities can be read off directly. By means of the scale it is possible to determine readily the B.t.u. theoretically available per pound of expanding steam, the resultant velocity of the steam, the steam consumption of a perfect engine operating between the given limits and the duty in million foot-pounds per thousand pounds of dry steam. The chart may be had upon application to the company.

Sale of Condemned Equipment at Brooklyn Navy Yard

Sealed proposals are invited by the government for the purchase of the condemned stores at the Brooklyn Navy Yard, the sale of which will take place on May 27.

THE MEMBERS OF THE BAVARIAN TECHNICAL MUSEUM COMMISSION

(From a photograph taken on board the "Amerika" on arrival, reproduced by courtesy of the New York "Staats Zeitung.")

Reading from left to right: Mr. Orth, Civil Engineer; Dr. Ross, Secretary of the Commission; Dr. von Borscht, Mayor of Munich, Privy Councillor; Dr. Fuchs, Civil Engineer; Count von Podewils-Durniz, President of the Museum, former Prime Minister of Bavaria; Mr. Trautwein, Civil Engineer; Dr. Oscar von Miller, President of the German Society of Engineers and Professor in the Munich Polytechnic; Mr. Gelius, Architect to the Commission; Prof. Dr. von Dyck, Rector emeritus, Technical University of Munich.

Among the machinery to be sold are condensing engine-driven air compressors, intercoolers and receivers, McIntosh-Seymour cross-compound condensing engines, Westinghouse 220-volt generators, Blake plunger pumps, feed-water supply tanks, hotwell tanks, power-plant piping, traps, fittings, headers, complete electrically driven elevator equipments, etc.

Schedules containing the full particulars, form of proposal and terms of sale may be obtained upon application to the Paymaster of the Navy Yard.

The German Industrial Museum

On Tuesday evening, Apr. 9, Dr. Oscar von Miller, director of the industrial museum at Munich, presented to the American Society of Mechanical Engineers, at New York, a paper illustrated by lantern slides upon the museum and its work. Photographs of many of the more interesting exhibits and those illustrating the methods of presentation and demonstration of various subjects and processes were thrown upon the screen.

The lecture was followed by the presentation by Dr. W. von Dyck of the biography, written by himself, as a part of the museum's activities, of the eminent German chemist Karl von Reichenbach, and by a reception in the rooms of the society.

The occasion was an advantage taken of the presence in this country of the Commission of the museum whose photographs, taken upon their arrival, are shown herewith. They will study industrial and museum methods as followed here and it is hoped that their visit may inspire interest in the establishment upon this side of the water of a museum to preserve the history of our industrial development to exemplify its processes and exhibit its products.

Dr. Denton Honored by Mechanical Engineers

The alumni of Stevens Institute of Technology recently paid a tribute to the mechanical genius and strong personality of Dr. James E. Denton, who has long been associated with the institute faculty. He has been forced by impaired health to retire from the activities of his profession as engineer and teacher, and the alumni seized upon the occasion to present him a token of love and esteem in the form of a watch and fob accompanied by an engraved testimonial containing the signatures of a majority of the alumni and the professors.

Dr. Denton has gained a world-wide reputation in steam engineering. In 1906 the degree of doctor of engineering was conferred on him, and he has, therefore, the distinction of being the first Stevens alumnus to receive this degree from his college. He was graduated in 1875.

WATCH AND FOB PRESENTED TO DR. DENTON

Accompanying the gift was a description of the symbolic significance of the watch and fob, which are the work of F. Walter Lawrence, a well known goldsmith of New York City.

Modern Science Club's New Officers

The annual election of the Modern Science Club was held on Tuesday evening, Apr. 9, in the club house, at 125 South Elliott Pl., Brooklyn, N. Y. The following officers and directors were elected for the ensuing year:

President, John P. Bonney; vice-president, C. H. Haggerty; treasurer, George O. Kaley; financial secretary, J. W. Sterrett; secretary, John P. Martin.

Board of directors: E. G. Gennert, Frank Martin, J. H. Baumann, William Smith, W. G. Freer, F. J. Wood, J. A. Donnelly, H. A. Forward, George A. Diack, H. J. Murphy.

National Heating Association Convention

The National District Heating Association will hold its fourth annual convention in Detroit, Mich., June 25, 26 and 27.

The progress of the convention will include an address of welcome by the

mayor of Detroit, and Alexander Dow, of the Edison Illuminating Co. The following papers will be read: "Common Sources of Trouble in Customers' Installations," W. E. Darrow, Merchants Light, Heat & Power So., Indianapolis, Ind.; "Quality of Steam as Served by Central Stations to Their Customers," A. C. Shepherd, Cleveland Electric Illuminating Co., Cleveland, Ohio; "An Analysis of Heating Rates," A. E. Duram, Central Station Engineering Co., Chicago, Ill.; "Heating in Connection with Curtis Steam Turbines," August H. Kruesi, General Electric Co., Schenectady, N. Y.; "Description of a Combined Steam Heating, Ice Making and Electric Power System," J. T. Lewis, manager, Murphy Heating Co., Detroit, Mich.; "Description of a Large Hot-water Heating System," G. E. Chapman, Public Service Co., Chicago, Ill.; "De-centralized Steam Plants," S. M. Bushnell, Chicago, Ill.; "Depreciation in Underground Distribution Plants," W. Jennings, Harrisburg Steam Heat & Power Co., Harrisburg, Penn.; "Economic Survey of Combined Power and Heating Systems," E. D. Dreyfus, Pittsburg, Penn. The committees on rates and central-station records will make their reports, and a description of underground insulation, by a number of manufacturers of such insulation, will be given.

The entertainment for the convention will include an auto ride for the ladies on Tuesday afternoon; a theater party at Temple Theater on Tuesday evening; Wednesday afternoon a boat trip to the Flats, with the afternoon session on the boat and supper at the Flats; for the ladies, on Thursday morning, a card party.

The association has charge of the exhibit hall and arrangements for space at the exhibit should be made directly with the secretary. The headquarters will be at the Hotel Cadillac, and reservations for rooms should be made directly with the hotel. All inquiries regarding the convention should be directed to D. L. Gaskill, secretary, Greenville, Ohio.

Philadelphia Asks Aid of I. O. E.

That the city of Philadelphia is anxious to have the Institute of Operating Engineers assist in its department of public works, is evidenced by the recent request of officials of the city to that effect. President J. C. Jurgensen visited the different power plants of the department of public works of that city in February.

The public officials of Philadelphia hope to so arrange matters that the Institute of Operating Engineers diploma will be credited as equivalent to a certain percentage on any civil-service examination paper. Should this be carried through, it will constitute a recognition as yet given to no engineering society and will be an authoritative indorsement to the work of the institute.

Cleveland's "Engineers' Day"

The success of the picnic and outing, held last year under the auspices of the Combined Engineers' Associations of Cleveland, at Luna Park, has encouraged its promoters to make even greater efforts for this year's event, which will take place on July 20, in Luna Park.

There will be the usual games, contests, drawings, etc., and the joint executive committee, composed of three delegates from each of the local engineers' organizations, is already actively engaged in planning new attractions.

Seattle Convention of the N. E. L. A.

Arrangements for the coming National Electric Light Association convention at Seattle, Wash., in June are well advanced, and the officers and committees held a meeting on Apr. 5, at Minneapolis, to report on their work.

In an early issue will appear an outline of the work to be done at the meetings and the list of papers to be read, as well as the preparations that have been made for the visiting members' entertainment.

SOCIETY NOTES

The 1912 annual meeting of the American Association of Refrigeration will be held in Washington, D. C., on May 6 and 7. The sessions on May 6 will be held at the New Willard Hotel and on the seventh at the Bureau of Standards, where lucheon will be served. Further particulars as to the program and questions to be considered at the meeting will be announced at an early date. It is hoped that final action on the plans for the Third International Congress of Refrigeration may be taken at this meeting.

BOOKS RECEIVED

ALTERNATING-CURRENT DESIGN. By Julius Frith. D. Van Nostrand Co., New York City. Cloth; 118 pp., 5¼x8½ in.; illustrated. Price, $2.

ASSOCIATION EDUCATIONAL WORK. By George B. Hodge. Association Press, New York. Cloth; 256 pp., 5x8 in.; fully illustrated. Price, $1.

THE ELEMENTS OF STRUCTURES. By George A. Hool. McGraw-Hill Book Co., New York. Cloth; 188 pages, 6x9 in.; 143 illustrations; indexed. Price, $1.75.

MECHANICAL EQUIPMENT OF FEDERAL BUILDINGS. By Nelson S. Thompson. Williams & Wilkins Co., Baltimore, Md. Cloth; 277 pp., 5¾x9 in.; charts. Price, $2.

ELEMENTARY MECHANICAL REFRIGERATION. By F. E. Matthews. McGraw-Hill Book Co., New York. Cloth; 172 pp., 6x9 in.; illustrated; tables. Price, $2.

REFRIGERATION, COLD STORAGE AND ICE MAKING. By A. J. Wallis-Taylor. D. Van Nostrand Co., New York. Cloth; 632 pages, 5½x9 in.; 414 illustrations; tables; indexed. Price, $4.50.

NEW PUBLICATIONS

STEAM POWER PLANTS; Their Design and Construction. By Henry C. Meyer, Jr. Published by McGraw-Hill Book Co., New York, 1912. Size, 5¾x9 in.; 219 pages; 88 illustrations, including 21 large-size plates; cloth. Price, $2, net.

This is the third edition of this book, rewritten and enlarged. The original work is so widely and favorably known that to say that the present edition is good amounts to sheer redundance.

Shortly after the first edition was published, in 1902, the author gave up the editorship of the *Engineering Record* and began to practice as a consulting engineer for power-plant design and construction. The experience thus gained, he says in the prefatory note to the present issue, led him to make some changes and many additions when he came to the work of revising the book. The chapter on steam turbines has been added, also much new matter on the subjects of steam piping, condensers and chimneys. In addition to these subjects, the book contains two chapters on steam boilers, their proportions, design, selection and erection; two on the selection of engines, dimensions of the cylinders, speed, steam pressure, general specifications, etc., and one chapter each on condensers and pumps, feed-water heaters and economizers, mechanical draft, and coal handling, water supply and purification.

This book should be especially valuable to all who are not professional designing engineers and who may have occasion to lay out a new plant, remodel an old one or purchase and install any pieces of power-plant equipment.

PERSONAL

Irving H. Reynolds, who was formerly chief engineer of the Allis-Chalmers Co., and later with the William Tod Co., of Youngstown, Ohio, has again entered the employ of the former company.

Frederick S. Palmer, well known as an expert in his line, has assumed the position of general manager of the automatic engine-stop department of the Metallic Packing & Manufacturing Co., Elyria, Ohio.

Mancius S. Hutton, Jr., has just become associated with Frederick A. Hall in his engineering and sales offices at 5 to 9 Beekman St., New York City. Mr. Hutton, who is the son of Prof. Frederick R. Hutton, honorary secretary and past-president of the American Society of Mechanical Engineers, will give special attention to the departments of boilers, engines and power equipment in which Mr. Hall acts as the direct representative of manufacturers.

Moments with the Ad. Editor

"Advertising is the great epoch-making short-cut in business building. It has dynamic power—and it is like dynamite itself, in that it isn't a very good thing for the novice to fool with."

This message comes out of that brisk and beautiful, one-quarter French, four-quarters American City of the Straits, Detroit, —from the pen of Hugh Chalmers.

Everyone knows *him*.

The tale how he left the N. C. R., built a motor car, then, on "nerve," built a motor car company to sell it, is common property.

Hugh Chalmers is one of those fellows with the guts, go-to-it, and telescopic foresight, who have made Detroit the "Automobile Capital of the World"—as she is. An example of the third quality, we might pause to say, came forth only last year when, under slackening business conditions and diminishing sales in every line, Hugh Chalmers went on making his cars at full capacity and storing those unsold cars on floor after floor of his warehouses. He *knew* the demand would come back. Suddenly the call came: "Cars!" He had 'em.

And now, accept it from us, this man has the right idea about *advertising*.

Advertising is a *short-cut*—and it is *dynamite*.

Advertising is like the tunnel under the Hudson by which a man shoots in two minutes direct from Jersey to Manhattan instead of by the slower, uncertain, antique ferry boat. Advertising *gets past* the slow, costly, illogical delays and wastes of has-been selling methods, good enough for one time—but not sufficient for ours. It establishes the direct, lasting relation between the man who manufactures and him who eats, wears, uses. It is the sure mile-a-minute tunnel train from maker to consumer.

But—*it is also dynamite*. And no more than we would think of trusting a green workman to decide when, where, and how to set off a blast of giant powder in cutting a tunnel beneath the Hudson or under the streets and buildings of New York, with the uncalculated stake of life and property above, so no more *ought* we to think of trusting an irresponsible novice to handle advertising. Advertising, wrongly used, can do tremendous almost irremediable disaster to advertising as a whole,—exactly as the persistently wrong and careless use of dynamite, when it was first placed on the market, *would have* created a lasting public prejudice against *its* use henceforth, *by anyone*.

A dishonest, misleading, exaggerated advertisement, skillfully written—spread big—will have the same destructive consequence as a blast of giant powder wrongly placed. It'll *do things*—bowl over a horde of so called "suckers," most of whom, however, are just ordinary people like you and us, who have been gradually taught to believe in advertising sincerity.

What's the result?

When these people find they have been "stung," as the phrase is, their trust is just that much shaken in advertising as a whole. They suspect *all* advertising.

What would you do with a man who deliberately touched off a stick of dynamite under a Broadway sidewalk and maimed or killed dozens of people? What would you do with a boss who allowed a green workman to handle explosives and so blunderingly to kill or endanger the lives of his fellows? What should be done with the man who by irresponsible or dishonest handling of *the other dynamite*, advertising, shakes public confidence in this essential of modern business building?

The question is up to *you*, as much as anyone, for decision. One way is to *squelch* such advertising into impotence *by neglect*. And one sure way to do that is to patronize only the advertisements of the publication which *guarantees the exact truth* in its Selling Section.

NEW EQUIPMENT

ATLANTIC COAST STATES

Rockland, Mass., will soon vote on the proposition to install a municipal electric-light plant.

Thomas L. Hisgen, West Springfield, Mass., is interested in the proposed construction of a municipal electric plant.

The Collinsville Co., Collinsville, Conn., plans to build a power plant on the Farmington River, to supply electricity to operate its mills.

The Middletown Electric Light Co., Middletown, Conn., will construct two additions to its power plant. A turbine engine and two boilers will be installed. T. N. Golden is general manager.

The Sodus Gas & Electric Co. plans to build an electric-light plant at Cohocton, N. Y. G. R. Mills, Sodus, is general manager.

Oneida, N. Y., is considering the improvement of the water-works system at a cost of $10,000. Charles Fitzgerald is superintendent of public works.

The Yonkers Electric Light & Power Co., Yonkers, N. Y., will construct a transformer station to cost $20,000. C. S. Shepard is purchasing agent.

Wyss Thalman, architect, Wabash Building, Pittsburg, Penn., is receiving bids for a two-story brick and concrete ice plant for the Iron City Ice Co., to be erected on Bedford Ave., Pittsburg, at a cost of $120,000.

A transformer station will be erected by the Public Service Ry. Co., adjoining the car house at Central Ave. and Fourteenth St., Newark, N. J., and which will involve an expenditure of $20,000. R. E. Danforth is general manager.

The merchants on Main St., Johnstown, Penn., contemplate the installation of an electric-light plant to supply electricity for their stores. Estimated cost, $4000.

The Pennsylvania Light, Heat & Power Co. plans to enlarge its power plant on the North Side, Pittsburg, Penn., by installing new boilers and stokers for the entire battery of boilers. A. Gray, Allegheny, is superintendent.

The Central District & Printing Telegraph Co., Pittsburg, Penn., contemplates the installation of new electrical equipment in its local plant.

Brunswick, Md., contemplates the installation of a municipal electric-light plant.

Bonds for $20,000 have been voted for the construction of an electric-light plant at Centerville, Md.

Frostburg, Md., is considering the installation of an electric-light plant.

SOUTHERN STATES

The Union Buffalo Cotton Mills, Union, S. C., will construct a steam-power plant, at a cost of $150,000.

Bids will be received by T. P. Scott, secretary of building committee, Mississippi Normal College, Hattiesburg, Miss., until Apr. 22, for installing an electric-light and power plant in the college.

George G. Earl, superintendent of the sewerage and water board, New Orleans, La., is preparing plans for the enlargement of the drainage-plant power station.

The Winnfield Ice & Cold Storage Co., Winnfield, La., will install a new engine and dynamo in its plant.

Corydon, Ky., contemplates the installation of an electric-light plant at a cost of $10,000.

The Shelbyville Water & Light Co., Shelbyville, Ky., will install new equipment in its plant. Ernest Vanarsdel is superintendent.

CENTRAL STATES

The officials of the Princeton Coal Mining Co., Princeton, Ind., are asking for bids for the electrification of their mine.

WEST OF THE MISSISSIPPI

P. A. Johnson, Atlantic, Iowa, will construct an electric-light plant at Anita, Iowa.

Defiance, Iowa, has voted to install a water-works system. Estimated cost, $8000.

John L. Therme, of Chicago, Ill., contemplates the installation of an electric-light plant at Lineville, Iowa.

Swea City, Iowa, has the installation of a municipal electric-light plant under consideration.

The city council, Luverne, Minn., contemplates the installation of additional electrical equipment in the municipal lighting plant, at a cost of $5000. C. N. Philbrick is superintendent of plant.

The Twin City Rapid Transit Co. is considering the installation of a new substation at Minneapolis, Minn., at a cost of $10,000. Horace Lowry is general manager.

Beach, N. D., contemplates the installation of a water-works system to cost $25,000.

The Commercial Club, of Binford, N. D., is considering the installation of an electric-light plant.

Clarksdale, Mo., is considering the installation of an electric-light plant.

Bond Nichols has received a franchise to construct an electric-light plant at Black Rock, Ark.

The Arkansas Cold Storage Co., Little Rock, Ark., contemplates the construction of an electric-light plant.

The installation of an electric-light plant at Port Aransas, Tex., is contemplated by the Jones & Cotter Co

The Malone Light & Ice Co. plans to install a new engine and other machinery in its power plant at Plainview, Tex. Thomas Malone is superintendent.

Decatur, Tex., will rebuild its electric-light plant which was recently destroyed by fire. Estimated cost, $16,000. T. J. Crawford is manager of plant.

Denton, Tex., will increase the capacity of the municipal electric-light plant by installing new equipment. H. C. Storrie is superintendent of plant.

The United States Portland Cement Co. is considering the installation of a 1500-hp. power plant at Concrete, Colo. William Fowden is superintendent.

Hillyard, Wash., is considering the installation of a municipal electric-light and power plant.

D. E. Keasey and associates, Portland, Ore., are interested in the construction of an electric-light plant at Lyle, Wash.

Granger, Wash., proposes to install a water-works system at a cost of $15,000. Avery & Parks, Granger, are engineers.

The Tulare Power Co. proposes to construct a substation at Pixley, Calif.

The Noble Electric Smelter Co. will install three furnaces at its iron mines at Heroult, Calif. H. H. Noble is president.

Bids will be received by the board of public works, San Francisco, Calif., until Apr. 24, for the installation of electrical equipment in the substation for the Geary St. municipal railway.

The citizens of Gatineau, Que., are contemplating the installation of a new municipal electric-light system at a cost of $25,000.

The British Columbia Electric Ry. Co., Ltd., has prepared plans for the construction of a new substation on Earl's Road, South Vancouver, B. C. R. H. Sperling is general manager.

The British Columbia Electric Ry. Co., Ltd., contemplates the installation of new equipment in its auxiliary power plant at Victoria, B. C. Estimated cost, $25,000. R. H. Sperling, Vancouver, is general manager.

The Dominion Power & Transmission Co. will remodel its power plant at Dundas, Ont. W. C. Hawkins, Hamilton, Ont., is general manager.

High River, Alta., will receive bids, Apr. 30, for constructing a water-works system. C. R. Murdock is resident engineer.

The extension and improvement of the water-works system at Vancouver, B. C., is contemplated. Estimated cost, $650,000.

The Hoeschen Wentzlen Co. contemplates the expenditure of $20,000 for new equipment for the power plant in connection with its brewery at Nutana, Sask.

BUSINESS ITEMS

"Terry Service" is the title of an attractive and well illustrated booklet just brought out by the Terry Steam Turbine Co., Hartford, Conn. It shows the wide range of uses of Terry turbines driving generators, pumps, forced draft and gas blowers, and also gives the names of prominent installations. This booklet will be sent on request to the Terry Steam Turbine Co., 90 West St., New York, or any of its offices.

NEW CATALOGS

Bristol Co., Waterbury, Conn. Bulletin No. 132. Recording ammeters. Illustrated, 48 pages, 8x10½ in.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 60. Indicating gages. Illustrated, 16 pages, 8x11 in.

E. Keeler Co., Williamsport, Penn. Catalog. Water-tube boilers. Illustrated, 46 pages, 7½x10½ in.

Brown Hoisting Machinery Co., Cleveland, Ohio. Pamphlet S. Suspended coal bins. Illustrated, 36 pages, 6x9 in.

Franklin Oil Filter Co., St. Louis, Mo. Catalog. Oil filters, tanks, cabinets, fittings. Illustrated, 36 pages, 6x9 in.

General Electric Co., Schenectady, N. Y. Bulletin No. 4940. Commutating pole motors. Illustrated, 8 pages, 8x10½ in.

Murphy Iron Works, Detroit, Mich. Booklet. The Murphy furnace in the paper mill. Illustrated, 48 pages, 4½x6¼ in.

Kelly Foundry & Machine Co., Goshen, Ind. Catalog B. Rocking, dumping and stationary grates. Illustrated, 24 pages, 6x9 in.

The Goulds Manufacturing Co., Seneca Falls, N. Y. Booklet. Air pressure and vacuum pumps. Illustrated, 15 pages, 3½x5½ in.

Mayville Specialty Manufacturing Co., Mayville, Wis. Catalog. Horizontal tub-

ular boiler setting. Illustrated, 30 pages, 4¾x7¾ in.

Lytton Manufacturing Corporation, 50 Church St., New York, N. Y. Pamphlet No. 1, steam traps. Illustrated, 4 pages, 6x9 in. Pamphlet No. 4, Pressure reducing valve. Illustrated, 4 pages, 6x9 in. Pamphlet No. 5, Vacuum trap. Illustrated, 4 pages, 6x9 in. Pamphlet. Boiler blow valve. Illustrated, 4 pages, 3½x6 in.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

A CAPABLE, progressive, licensed engineer is wanted to run the power plant in a Brooklyn (N. Y.) store; must know steam and electrical machinery, be able to work himself and get others to work; a good factory engineer, accustomed to relying upon himself, will have preference; pay $100 per month. Apply by letter, stating qualifications and references. Box 642, Power.

MANUFACTURING PLANT in Tennessee; want a married man who can run cross-compound Hamilton-Corliss engines (24x48x48) Heine boilers, electrical generators and switchboards; must be thoroughly competent to maintain, repair, and keep the plant in continuous operation; state your qualifications and the salary you want. Box 643, Powtr.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

AGENTS WANTED to sell forced draft blowers and damper regulators; will give exclusive territory to right parties; commission on sales. Turbo-Blower Co., 30 Church St., New York.

AGENTS selling to steam plants can make big money selling for us; no samples; no experience is necessary. Armstrong Mfg. Co., Springfield, Ohio.

A WELL KNOWN manufacturing corporation desires additional agents to handle a power plant specialty backed by first grade advertising. Box 638, Power.

AGENTS WANTED—We want a live wire agent, either engineer or specialty salesman, in every town to furnish lists of names and take orders for Akron metal gaskets, the most complete line of metal gaskets made. Write for our proposition. Akron Metallic Gasket Co., Dept. P, Akron, Ohio.

ENGINEER for power plant of new factory, one with experience in electric power plant service; should be familiar with crude oil or gas engines; state experience, periods and places of employment, age and salary expected. Address "Engineer," Box 1574, Springfield, Mass.

AGENTS for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

MANUFACTURERS' AGENTS to handle thoroughly guaranteed steam specialties; feed water heaters, steam and oil separators, traps and exhaust pipe heads; not necessary to represent entire line if interested in only part of it; our specialties are well advertised and of good reputation. Box 569, Power.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

GAS ENGINEER, now in charge of 1200-kw. plant, desires a change; good reasons; married, sober and have excellent references; will go anywhere. Box 639, Power.

AS SUPERINTENDENT of electric light and water-works system in medium sized town; seven years in this position; best references; sober and married; come on 30 days' notice. Box 641, Power.

MECHANICAL and electrical engineer, age 34, with broad technical and practical experience in design, installation and operation of power plant apparatus, steam turbines and general machinery, capable of handling mechanical equipment in large plant, desires position as chief engineer or superintendent. Box 640, Power.

A GOOD practical engineer desires position; has experience in running high and low speed engines, dynamos, ice machines, storage batteries, turbines, etc.; can read, take and work from drawings and blueprints; machinist by trade, and studied the theoretical part of mechanical engineering during spare time. Box 637, Power.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

WANTED, complete 1910 volume "Power" in good condition. Box 630, Power.

PATENTS SECURED—C. L. Parker, Patents, 904 G St., Washington, D. C.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. M. Y. C., 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

CHEAP—One 30-hp. Diesel oil engine with duplicate parts of a wrecked one. Seib Bros., 96-100 Boyd Ave., Jersey City, N. J.

13½"—26"x18" "FLEMING" Harrisburg cross compound medium speed engine; extremely compact, occupying a space of 8'x12'; price low before removal. J. F. Foster, 166 Devonshire St., Boston, Mass.

12x34 BROWN Corliss engine, $400; 13x12 Atlas 4 valve engine, $500; 16x36 Allis Corliss engine, $650; 17x24 Russell 4 valve engine, $600; 20x48 George Corliss engine, $650. Duzets & Son, Hudson Terminal, New York.

BARGAINS in second hand steam engines; 10x10 low pressure vertical New York Blower Co., 7x10x15 Atlas, 11½x16 throttling balanced valve, 10x12 Allfree, 12x12 Ideal, 15x14 Ideal, 10x20 Buckeye, 12x24 Buckeye, 17½x10x20 Buckeye. Power Equipment Co., Minneapolis, Minn.

ONE 120 kilowatt, a.c., 440 volts, Westinghouse generator, belted to 16x42 Allis Corliss engine, complete with exciter, switchboard and all fittings. One 20 kilowatt, d.c., 230 volt, C. & C. Electric Co. generator, direct connected to 8x10 Allfree engine. All of the above in fine shape. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

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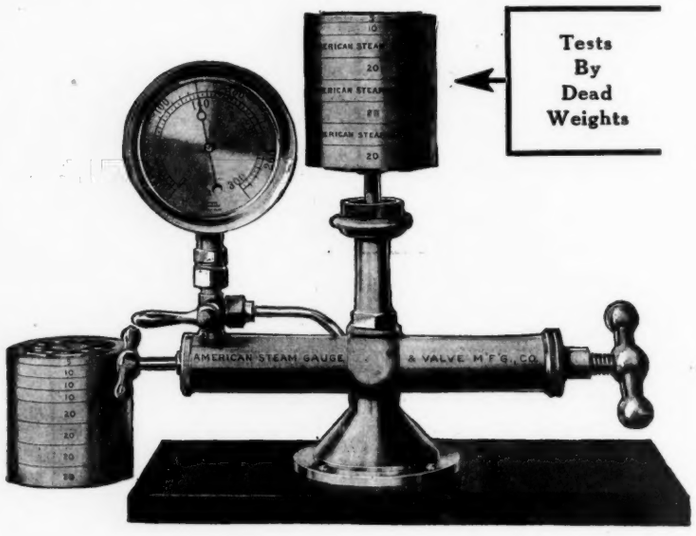

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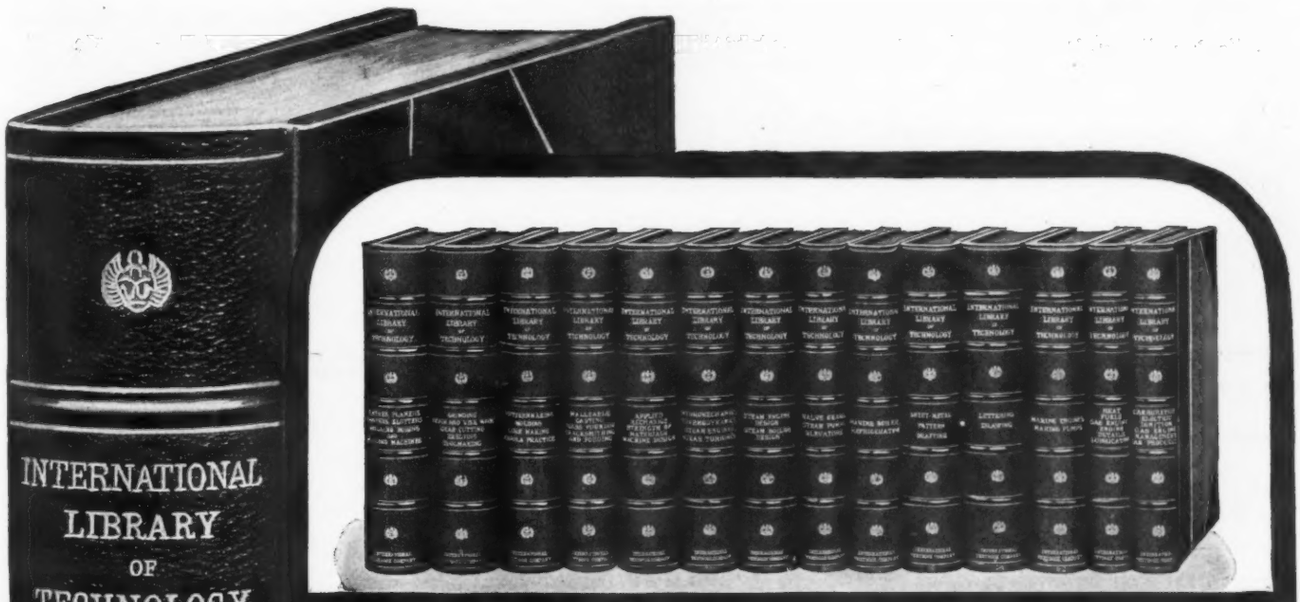

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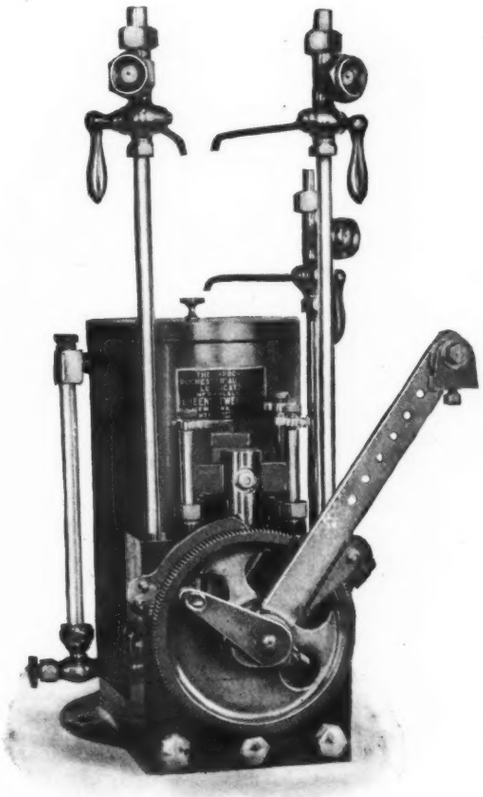

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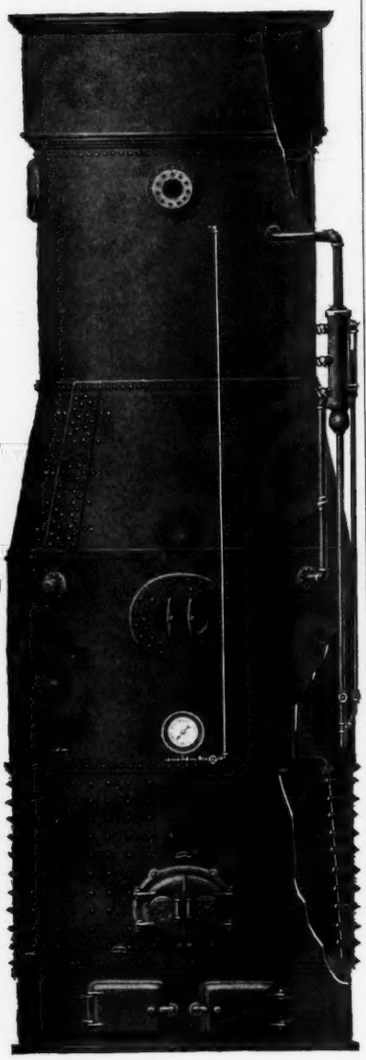

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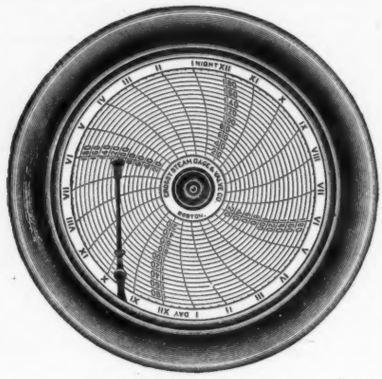

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